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Native Woodland Habitat Types of Southwestern North Dakota

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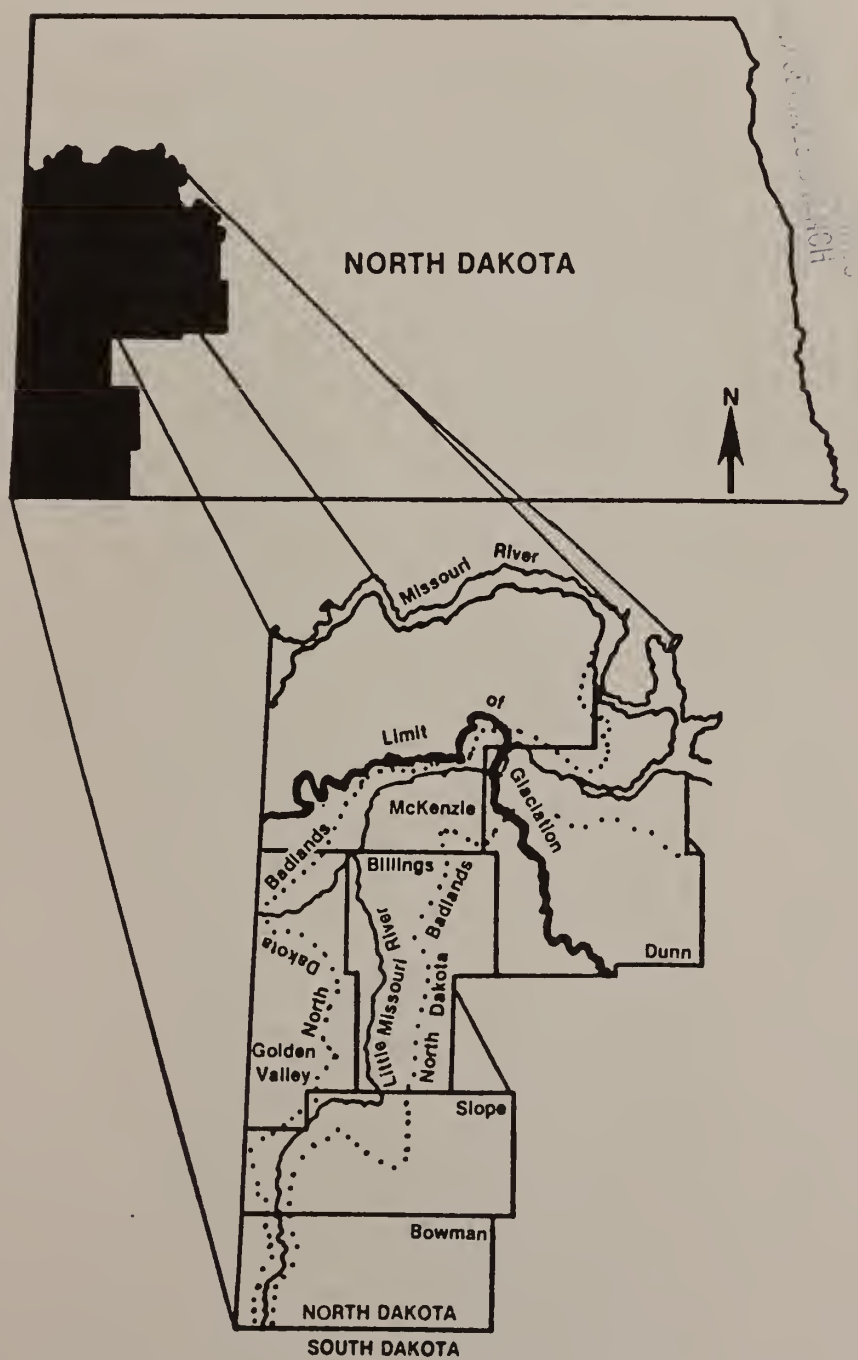

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Native Woodland Habitat Types of Southwestern North Dakota

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Abstract

Native woodland habitat types of southwestern North Dakota were classified. Forty-seven sites were sampled using Daubenmire methods and were analyzed using TWINSPAN classification and DECORANA ordination. A key was developed to identify habitat types, and the characteristics of each habitat type are described.

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Resource managers use habitat type information in the development of scorecards to rate the successional stage of vegetation on a site in relation to the potential natural community. By knowing the potential natural community of a site, the successional stage managers can assess the implication of their management systems in an ecological context.

As the pressures of resource development, livestock grazing, and recreation on rangelands increase, the need for comprehensive multiple-use management plans becomes more urgent. Basic knowledge of the resources is needed to develop these management plans. A first step is an assessment of the vegetation, its relation to environmental influences, and its biotic potential.

The Daubenmire (1952) method has been widely accepted throughout the West. Habitat typing has proven effective for classifying forests (Daubenmire 1952, Pfister et al. 1977), woodlands (Hansen et al. 1984, Girard 1985), steppe (Daubenmire 1970, Mueggler and Stewart 1980), and grasslands (Jorgenson 1979, Mueggler and Stewart 1980).

A habitat type is a collective area composed of similar edaphic, climatic, and topographic variables capable of supporting a certain, relatively homogeneous potential natural community (Daubenmire 1952). Sites with the same potential are classified within the same habitat type, regardless of the successional stage. Classification according to site potential allows for organization of information on resource potential, limitations, and response to management (Mueggler and Stewart 1980).

This study was initiated to develop a description and classification system for the native woodlands of southwestern North Dakota. Native woodlands form unique 'forested' ecosystems within the vast grasslands of the northern Great Plains. The woodlands constitute less than 5% of the vegetation of southwestern North Dakota (Jakes and Smith 1983), and only 1% of the northern Great Plains (Bjugstad 1978), but are important habitats for livestock, wildlife, biomass production, watersheds, species diversity, and soil stabilization. The study was a cooperative project between the Rocky Mountain Forest and Range Experiment Station, North Dakota State University, and Custer National Forest.

Relatively undisturbed woodlands were sampled throughout the study area to determine the potential natural communities for the sites. A key was designed for identifying the different habitat types. Information on the dominant and characteristic species, soil texture, topographic position, slope, and aspect have been integrated into the delineation of the habitat and community types and are presented for each type description.

STUDY AREA

The study area was in southwestern North Dakota in Billings, Bowman, Dunn, Golden Valley, McKenzie, and Slope counties (fig. 1). This area is commonly referred to as the Badlands or Little Missouri Grasslands.

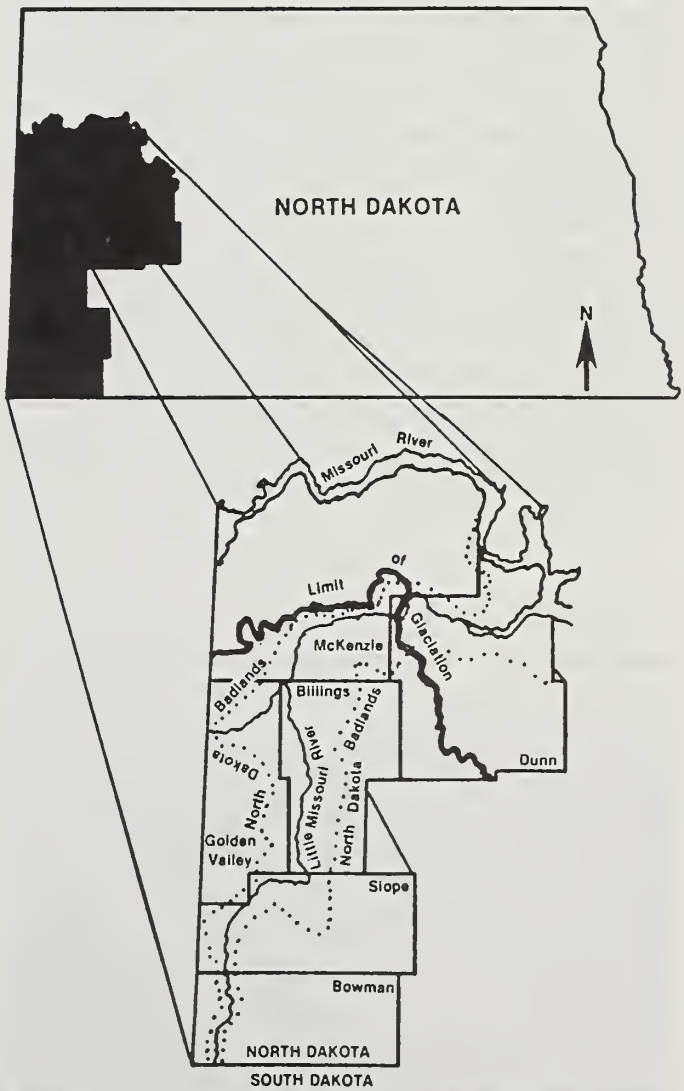

Figure 1.—A map of North Dakota showing the major physiographic features of the southwestern counties included in the native woodland study area (after Bluemle 1980).

Geology

Southwestern North Dakota is on the Missouri Plateau physiographic region which is subdivided into three areas—Badlands, unglaciated, and glaciated with drift remains (Fenneman 1931). Geological material consists primarily of sedimentary layers of shales, silts, clays, sandstone, and lignite veins of the Tongue River, Golden Valley, and Sentinel Butte Formations of the Fort Union Group (Bluemle 1980).

Topography

The establishment and survival of the woodlands is closely linked to topography and usually restricted to areas of increased moisture, which helps explain their limited distribution in the semi-arid climate. Most upland woodlands occur in upland intermittent drainageways on convergent landforms in coves, valley bottoms, and lower valley slopes (fig. 2) (Mack 1981, Butler et al. 1986). Riparian woodlands are limited to streambanks and floodplains of the Little Missouri River and its major tributaries (fig. 3). North-facing slopes support deciduous and coniferous species (fig. 4). The woodlands of the Killdeer Mountains are the result of unique topographic, edaphic and climatic conditions (fig. 5). The soils of "scoria" buttes favor the tap root system of some woody species (fig. 6).

Soil moisture on these sites is greater because of one or a combination of the following factors: run-in from adjacent uplands, springs or seeps from through-flow of upper topographic positions, interception of the water-table, decreased evaporation, flooding, and/or increased snow catch. Topography has been cited as the primary agent controlling soil moisture, soil development, and plant nutrients in woodlands of west-central North Dakota (Wollenhaupt and Richardson 1982).

Soils

Most soils have developed from residuum (material weathered from rocks in place). Soils range from Mollisols under the well developed plant communities and Entisols where less development has occurred (Omodt et al. 1968). Alfisols and Inceptisols have also been mapped in some regions of southwestern North Dakota (Wright et al. 1982).

The most typical soil series in woodlands are Bainville, Havre, Huff, Sage, Bank, and Cherry (Nelson 1961).

Figure 2.—Woodlands in uplands along intermittent drainageways.

Figure 3.—Woodlands on the floodplains of the Little Missouri River.

Figure 4.—Woodlands on north-facing slopes.

Figure 5.—Woodlands in the Killdeer Mountains.

Figure 6.—Woodlands on "scoria" buttes.

Representative soil profiles (Nelson 1961, Richardson 1979, Wali et al. 1980, Mack 1981, Butler et al. 1986), topographic sequences of soil types (Mack 1981, Butler et al. 1986), soil moisture content by topographic position (Butler et al. 1986), and soil nutrients (Wali et al. 1980) have been described for many of the woodland communities.

Climate

The climate of southwestern North Dakota is classified as semi-arid continental, characterized by wide daily fluctuations in temperature and erratic precipitation (Jensen 1972). The number of frost-free days ranges from 110 to 135 per year, averaging 125 over most of the area. Precipitation usually falls in late spring and early summer as intense thundershowers of short duration. The long-term precipitation average is 33–41 cm annually, and the average temperatures range from approximately 21°C to 22°C in July and –13°C to –9°C in January (Jensen 1972).

Woodland Vegetation

The first work on woodlands of North Dakota Badlands described the structure and composition of four woody vegetation types—*Fraxinus pennsylvanica, Juniperus scopulorum, Populus deltoides*, and *Artemisia cana* (Nelson 1961). The structure and ecology of north-facing *J. scopulorum* slopes has been reported (Ralston 1960). Potter and Green described the ecology of *Pinus ponderosa* (1964a) and *P. flexilis* (1964b) in southwestern North Dakota.

The vegetation-environment relationships of woodland and shrub communities and soil algae in western North Dakota have been studied, and the following communities were recognized: (1) *Populus deltoides*, 3 subtypes; (2) *P. tremuloides-Betula papyrifera*, 6 subtypes; (3) *F. pennsylvanica-Ulmus americana*, 9 subtypes; (4) *Quercus macrocarpa*, 5 subtypes; (5) *J. scopulorum*, 3 subtypes; (6) *Pinus ponderosa*; (7) *A. cana*, 2 subtypes; (8) *Symphoricarpos occidentalis*, 3 subtypes; and (9) *Shepherdia argentea* (Wali et al. 1980).

F. pennsylvanica, U. americana, Populus tremuloides and *Acer negundo* L. are the dominant tree species of hardwood ravines in west-central North Dakota (Mack 1981). Butler et al. (1986) investigated the relationship of grazing and topographic influences on *F. pennsylvanica* communities in the North Dakota Badlands. Four woodland habitat types have been described in Theodore Roosevelt National Park, North Dakota: (1) *F. pennsylvanica/S. occidentalis*; (2) *F. pennsylvanica/Prunus virginiana*; (3) *Populus tremuloides/B. occidentalis*; and (4) *J. scopulorum/Oryzopsis micrantha* (Hansen et al. 1984).

METHODS

Site Selection and Condition

Naturally occurring woodlands which showed near-potential natural vegetation and were relatively free from disturbances were sampled. Stands may have been lightly utilized but were relatively undisturbed, had high vigor, and homogeneous distribution of vegetation.

Habitat types were designed to deal with potential natural vegetation; but seral stages of woodlands also were sampled if they were in good to excellent condition. Seral community types were included, because they compose a significant portion of the woody vegetation.

Species composition also is important in condition determination. The presence of invader species indicates some type of disturbance; but the concept of invader species has not been developed in, or applied to native woodlands. Currently, only non-native plants are termed invaders (e.g., *Poa pratensis, Arctium minus, Agropyron repens*, and *Bromus inermis*). It is difficult to locate woodlands which do not contain one or several invader species, because almost every stand has received some type of disturbance. Invader species are present in many woodlands considered to be in good to excellent condition, because these stands represent the best condition available.

The predominance of increaser or lack of decreaser species also may be helpful. The information currently available indicates that *Rosa woodsii* and *Poa pratensis* may be increaser species in moderately grazed *F. pennsylvanica* woodlands (Nelson 1961, Butler et al. 1986). *Apocynum androsaemifolium* may be a decreaser, because it was a principal species on lightly and moderately grazed sites but was noticeably absent from a heavily grazed site (Butler et al. 1986). *Carex sprengelii* also appears to be a decreaser with grazing (Nelson 1961, Butler et al. 1986). Further research may help quantify these and reveal other indicator species.

Several points were considered when selecting native woodland study sites. Communities with tree species present in different size classes were selected. A dense shrubby understory cannot alone constitute high condition. Grazing may be detrimental to the success and survival of tree species, while enhancing shrub growth to

a point. The most diverse communities are not always in the best ecological condition. The presence of indicator, invader, and increaser species may be helpful in determining the community's condition, but these elements also need to be used together with other factors.

The following information was recorded for stands selected for analysis: legal description, general location, topography, slope, exposure, drainage, plot location, species list, and a general description of the site.

Vegetation Sampling

Vegetation sampling methods were modified from Daubenmire (1952) and Mueggler and Stewart (1980). A 20-m x 20-m macroplot was established within a stand where vegetation was most homogeneous. Within this macroplot vegetation was divided into four strata: herbaceous, shrub, sapling, and tree. These strata were defined on the basis of size.

Herbaceous.—The Daubenmire (1959) canopy coverage system was used to visually estimate canopy coverage for herbaceous vegetation. With this method, all species (including young woody plants) less than 1 m tall were estimated in a 20-cm x 50-cm microplot. A total of 40 microplots were read, 20 along each of 2 evenly spaced transects.

Shrub.—All shrubs (woody vegetation less than 2 m but more than 30 cm tall) were measured in six circular milacre plots, three along each transect. Species, height, crown, and number of stems were measured for each shrub rooted within the plot.

Sapling.—Woody vegetation more than 2 m tall and less than 10 cm d.b.h. was included in the sapling category. Height, crown, vigor, diameter, and origin were recorded. Origin refers to whether the sapling is a single stem, multiple stem, or a root sprout whenever possible to visually determine. All saplings rooted in the 20-m x 20-m macroplot were measured.

Trees.—Trees greater than 2 m tall and larger than 10 cm d.b.h. were included in the tree stratum. Methods for collecting tree data were identical to that for saplings.

Strata were defined solely on the basis of height and/or diameter. Therefore, a tree species such as *Fraxinus pennsylvanica* may be sampled in the herbaceous, shrub, sapling, or tree layer. Low growing, spreading woody species, such as *Juniperus communis* L. and *J. horizontalis*, were sampled in the herbaceous strata only. *J. scopulorum* diameter was measured 10 cm from the ground, rather than at breast height.

Data Analysis

Preliminary analyses were performed using the Statistical Analysis System (SAS) (Bare et al. 1979) to calculate total and relative cover, and density values by species and by site. This information was used to make subjective classifications based on similarity of dominant species, floristics, species composition, total and relative cover values, and density values. The physical information for each site was reviewed to determine if actual site similarities existed within groups. Variability within and between groups was reviewed in order to identify consistent types.

Two analyses were conducted: Two Way Indicator Species Analysis (TWINSPAN), a classification technique (Gauch and Whittaker 1981); and Detrended Correspondence Analysis (DECORANA), an ordination space partitioning technique (Hill and Gauch 1980). TWINSPAN and DECORANA are both polythetic divisive techniques which utilize the principles of reciprocal averaging explained by Gauch (1982).

These results and "ecological sense" were cross-referenced to develop reliable groups which fit the definitions of a habitat or community type, and to develop a key to identify the types in the field.

Soil Sampling

Soil samples were collected at five locations at each site—the corners and the center of the macroplot. A composite sample of 15 cm increments from each of the five locations was collected. Samples were collected at depths of 90 cm where possible. Bedrock, stones, and "scoria" soils prevented the collection of complete samples at some sites. Analyses for pH were done by the North Dakota State University Soil Testing Lab, Fargo. Soil texture analysis was conducted using the Bouyoucos hydrometer method (Day 1965) for percent sand, silt, and clay by the Rocky Mountain Forest and Range Experiment Station, Rapid City, S. Dak.

Taxonomic Considerations

Identification of plant collections was conducted at the North Dakota State Herbarium. Nomenclature follows the *Flora of the Great Plains* (Great Plains Flora Association 1986).

It often was necessary to identify sterile, vegetative, fragmented, or otherwise incomplete plant specimens in the field. Positive species identification could not be made in many instances. When it was possible to identify the specimen to the generic level, but not the species, the genus was indicated. When it was not possible to identify the genus, the plant was listed as an unidentifiable forb or grass.

Specific examples include that of the genus *Symphoricarpos*. Two species, *S. occidentalis* and *S. albus*, were found in the study area. Positive identification is difficult without a flower or fruit; therefore, both have been listed as *S. occidentalis*, which appeared to be the most common. When it was possible to determine the species, it appeared that the frequency of *S. albus* increased in the Killdeer Mountains and the north-easterly portions of the study area. However, even when it was possible to determine the species, it always was listed as *S. occidentalis* to maintain uniformity. The taxonomy of the genus *Carex* also was difficult. When positive identification was possible, it was included. In most instances the

reproductive structures were not available, and these specimens were grouped and identified only as *Carex* spp.

RESULTS AND DISCUSSION

Classification of the Habitat and Community Types

Three methods of data analyses were integrated to develop the habitat and community type classification: subjective classification, TWINSPAN classification, and DECORANA ordination. The results of these analyses and the most important or obvious criterion for making the classification divisions are briefly explained for each analysis. A more complete description of the similarities or dissimilarities of the types is given in the Community Descriptions, Summary, and Appendix A.

Final Classification

The final classification of woodlands sampled in southwestern North Dakota recognized nine habitat types, one phase, and five community types (table 1). The final classification is given first, so that the other data analyses results can be readily compared.

Subjective Classification

The first subjective division was based on the dominant tree species (table 2). The woody understory of these groups was then examined to determine if the dominant tree species were reproducing or seral. The next grouping was based on differences of understory species, the presence or absence of certain key species, and their relative abundance. The physical site characteristics of sites within each grouping were then compared for similarities.

TWINSPAN Classification

All vegetation layers were analysed using TWINSPAN classification. The total cover values for each species were used for the analysis. The usefulness of the herbaceous and tree data was limited. The high variability of the herbaceous layer resulted in small groups of only a few sites. Low variability of the tree layer yielded few large groups.

The most useful TWINSPAN classification resulted from the combination of the shrub and sapling data. The shrub and sapling layers were pooled to perform the analysis; but each layer remained distinct through the calculations. The species were identified according to the layer where they were sampled; a species in the shrub layer, *Fraxinus pennsylvanica* for example, was treated as a "different species" than *F. pennsylvanica* in the sapling layer. This combination resulted in a greater degree of refinement in the classification than was achieved with the shrub or sapling layer separately.

Table 1.—Classification of woodland sample sites of southwestern North Dakota into habitat and community types.

Fraxinus pennsylvanica Series
- *Fraxinus pennsylvanica/Prunus virginiana* Habitat Type
  Sites 2, 11, 42
- *Fraxinus pennsylvanica/Prunus virginiana* Habitat Type
  Ulmus americana phase
  Sites 8, 27, 31, 32, 33, 35, 41
- *Fraxinus pennsylvanica/Symphoricarpos occidentalis* Habitat Type
  Sites 26, 30, 43
- *Populus deltoides/Fraxinus pennsylvanica* Community Type
  Sites 17, 34
- *Populus deltoides/Juniperus scopulorum* Community Type
  Sites 4, 13, 21, 29

Populus tremuloides Series
- *Populus tremuloides/Prunus virginiana* Habitat Type
  Sites 7, 10, 16, 25, 28, 36, 39
- *Populus tremuloides/Betula papyrifera* Community Type
  Site 19

Quercus macrocarpa Series
- *Quercus macrocarpa/Prunus virginiana* Habitat Type
  Sites 37, 40
- *Populus tremuloides/Quercus macrocarpa* Community Type
  Site 38
- *Quercus macrocarpa/Corylus species* Habitat Type
  Sites 5, 20, 23
- *Betula papyrifera/Corylus cornuta* Community Type
  Site 6

Betula papyrifera Series
- *Betula papyrifera/Clematis occidentalis* Habitat Type
  Site 22

Juniperus scopulorum Series
- *Juniperus scopulorum/Oryzopsis micrantha* Habitat Type
  Sites 3, 12, 45

Pinus ponderosa Series
- *Pinus ponderosa/Juniperus scopulorum* Habitat Type
  Sites 9, 15, 24, 44

Pinus flexilis Series
- *Pinus flexilis/Agropyron spicatum* Habitat Type
  Sites 46, 47

A drawback to using only the shrub and sapling data is that the tree layer, which is an important characteristic of the woodlands, was not used. This resulted in some sites appearing to be very similar to sites with a different climax species, and dissimilar to sites with the same climax species. The tree layer was not pooled with the shrub and sapling data, because it tended to mask the seral status of some of the sites and the similarity of the understory between sites dominated by different tree species. The tree data were always reviewed before a final grouping was made.

TWINSPAN performed a number of iterations which generated a matrix with sites arranged along one axis and species along the other (table 3). The gradient used for this arrangement appears to be moisture based on species characteristics and physical site information.

Corylus species distinguished the Killdeer Mountains and adjacent sites (Sites 22, 5, 6, 20, and 23) from those of the surrounding plains. The *Betula papyrifera/Clematis occidentalis* habitat type (Site 22) was separated from the

Table 2.—The criteria used for the subjective classification of woodland habitat and community types of southwestern North Dakota.

Step 1. Division of sites based on the dominant tree species.

1. *Fraxinus pennsylvanica*
2. *Populus deltoides*
3. *Populus tremuloides*
4. *Quercus macrocarpa*
5. *Betula papyrifera*
6. *Juniperus scopulorum*
7. *Pinus ponderosa*
8. *Pinus flexilis*

Step 2. Regrouping of sites based on the dominant climax tree species and differences in understory species.

1. *Fraxinus pennsylvanica*
   Sites 2, 8, 11, 26, 27, 30, 31, 32, 33, 35, 41, 42, 43-4, 13, -4, 13, 17, 21, 29, 34
   Prunus virginiana dominant in the understory
   Sites 2, 8, 11, 27, 31, 32, 33, 35, 41, 42
   Ulmus americana present
   Sites 2, 11, 42
   Symphoricarpos occidentalis dominant in the understory
   Sites 26, 30, 43-4, 12, 17, 21, 29, 34
2. *Populus deltoides*
   Sites 4, 13, 17, 21, 29, 34
   Populus deltoides not reproducing, move to *Fraxinus pennsylvanica*
3. *Populus tremuloides*
   Sites 7, 10, 16, 25, 28, 36, 38, 39-19
   Quercus macrocarpa reproducing
   Site 38 moved to *Quercus macrocarpa* Series
   Populus tremuloides reproducing
   Sites 7, 10, 16, 19, 25, 28, 36, 39
4. *Quercus macrocarpa*
   Sites 5, 20, 23, 37, 40-6, 38
   Corylus species present
   Sites 5, 20, 23-6
   Corylus species not present
   Sites 37, 40-38
5. *Betula papyrifera*
   Sites 6, 19, 22
   Betula papyrifera reproducing
   Site 22
   Quercus macrocarpa reproducing
   Site 6 moved to *Quercus macrocarpa* Series
   Populus tremuloides reproducing
   Site 19 moved to *Populus tremuloides* Series
6. *Juniperus scopulorum*
   Sites 3, 12, 45 - All had similar understories
7. *Pinus ponderosa*

other sites, because it had *B. papyrifera* reproduction. The reproduction of *Q. macrocarpa* and presence of *Corylus* species distinguishes the *Q. macrocarpa/Corylus* species habitat type (Sites 5, 20, and 23) and the *B. papyrifera/Corylus cornuta* Marsh. community type (Site 6). The *Q. macrocarpa/Prunus virginiana* habitat type (Sites 37 and 40) and the *Populus tremuloides/Q. macrocarpa* community type (Site 39) were similar to the *Q. macrocarpa/Corylus* species habitat type, but were separated because of differences in physical site characteristics and a number of floristic differences, the most important being the lack of *Corylus* species.

Sites 27 and 33 appear to be most similar to sites dominated by *Q. macrocarpa* in the TWINSPAN classification. The use of tree information resulted in these sites being classified as the *Fraxinus pennsylvanica/Prunus virginiana* habitat type *Ulmus americana* phase. The presence and relatively large amounts of *Amelanchier alnifolia* and *Cornus stolonifera* caused these similarities.

All stands with *Populus tremuloides* (Sites 10, 16, 25, 28, 36, 7, 19, 38, and 39) were shown to be similar in the TWINSPAN classification. The presence of *B. papyrifera* in the tree and sapling layer of Site 19 distinguished it from the other sites. *P. tremuloides* is reproducing in the shrub canopy, *B. papyrifera* is not, leading to the conclusion that this site is seral. Site 19 eventually was classified as the *P. tremuloides/B. papyrifera* community type. Site 38 also appears similar to the other *P. tremuloides* sites; but the presence of *Q. macrocarpa* reproduction led to its inclusion as the *P. tremuloides/Q. macrocarpa* community type under the *Q. macrocarpa/Prunus virginiana* habitat type. The remaining sites were classified as the *Populus tremuloides/Prunus virginiana* habitat type.

Most of the sites dominated by, or seral to, *Fraxinus pennsylvanica* were classified by TWINSPAN as similar in the woody understory layers (Sites 27, 33, and 41 were exceptions). The upland sites (Sites 27, 33, 8, 2, 11, 31, 32, 35, and 42) were aligned, followed by floodplain sites (Sites 4, 30, 17, 29, 34, 43, 26, 41, 13, and 21). The upland sites were further divided into the *F. pennsylvanica/P. virginiana* habitat type (Sites 2, 11 and 42) and the *Frax-*

Table 3.—The arrangement of woodland sites from TWINSPAN classification, based on the presence or absence and total cover values of species sampled in the shrub (B) and sapling (S) layers. Values for total cover classes are: 1 = 0–2%, 2 = 2–5%, 3 = 5–10%, 4 = 10–20%, 5 = 20–50%, 6 = 50–100 + %.

Species	Site Number
	2 2 2 3 4 2 3 1 1 2 2 3 1 3 3 1 3 3 3 4 1 3 1 2 3 4 2 4 1 4 1 2 2 4 4 4
	2 5 6 0 3 7 0 7 3 0 6 5 8 6 7 9 8 9 8 2 1 1 2 5 2 4 5 0 7 9 4 3 6 1 2 5 3 3 1 9 4 4 6 7
Corylus americana B	4 5
Betula papyrifera S	6 5
Corylus americana S	1
Corylus cornuta B	5 4 5
Corylus cornuta S	1 4 5
Sheperdia canadensis B	2 1
Crataegus rotundifolia S	3 1 1 2 2 1 1 3
Cornus stolonifera B	1 3 1 4 5 1 3 3 5 1 1 3 1
Cornus stolonifera S	2 2 4 2 5 2 4 2 5 4 2
Amelanchier alnifolia B	1 1 1 3 3 2 5 3 4 2 2 4 5 2 4 3 4 2 2 2 1 1 1
Amelanchier alnifolia S	1 3 4 4 1 4 3 2 4 4 4 3 1 3 2 3 2 2 3 1
Lonicera dioica B	1
Populus tremuloides B	1 1 3 3 1 3 1 4 5 5
Populus tremuloides B	3 3 1 5 6 4 3 2 4 5 5 6
Prunus pennsylvanica S	1 2
Ribes americana B	5 1
Salix spp. S	2 1 2 2 2
Viburnum lentago B	4
Viburnum lentago S	5 2
Betula papyrifera B	4
Quercus macrocarpa B	4 1 2
Quercus macrocarpa S	2 3 4 3 5 4 4
Prunus pennsylvanica B	1 1
Salix spp. B	1 1 1
Acer negundo S	1 1 2 1
Acer negundo B	1 3
Ulmus americana B	1 1 1 1 5
Prunus virginiana S	2 2 4 1 1 1 4 1 1 2 1 2 4 3 1 4 5 5 4 6 4 1 1 1 1 1 1
Ulmus americana S	1 2 4 3 3 2 5 2 2 5
Prunus americana S	1 2 2 1 1 3 4 2 1 2
Prunus americana B	2 1 1 4 1 1 1 1 1 2 3
Rhus trilobata S	1 2
Ribes odoratum B	1 2 1 1
Rosa woodsii S	1 2 1 1
Prunus virginiana B	4 4 5 6 6 4 4 5 4 5 6 2 5 5 3 3 1 4 5 6 6 6 6 5 3 3 2 1 1 1 1 1 1
Fraxinus pennsylvanica S	5 4 4 4 4 2 5 5 5 6 1 5 3 6 5 6 4 2 5 3 1 5 3 6 6 6 1 2 1
Rosa woodsii B	2 3 1 2 1 1 2 2 3 2 3 5 5 1 1 4 3 1 1 5 4 5 5 5 3 2 1
Ribes missouriense B	2 3 1 2 3 2 1 1 1 1 2 1 2 1 1 2 1 2 1 1
Fraxinus pennsylvanica B	1 2 2 3 4 3 2 2 1 3 1 4 3 2 2 1 1 2 3 2 3 1 3 2 5 2 4 4 1 5 2
Symphoricarpos occidentalis B	1 4 4 3 5 5 2 1 1 3 2 1 2 5 2 5 4 1 4 5 1 2 6 4 5 4 6 5 6 5 5 4 2 1 3 4 1 2 1
Ribes setosum B	1 1
Juniperus scopulorum S	1 1 3 2 3 3 5 5 3 4 5 2 3 1 2 3
Rhus trilobata B	1 3 1 1 1 1 2 1 1 4 1 1 3 1
Potentilla fruticosa B	1 2
Shepherdia argentea B	1
Juniperus scopulorum B	1 3 1 2 1 3 3 2 2
Pinus flexilis B	3
Ribes spp. B	2
Pinus flexilis S	5 5
Pinus ponderosa B	2 4 1
Pinus ponderosa S	2 4 5 3

inus pennsylvanica/Prunus *virginiana* habitat type *Ulmus americana* phase (Sites 27, 33, 8, 31, 32, 35, and 41) primarily based on the presence or absence of *U. americana*. Site 41 was not classified by TWINSPAN as similar to the other sites of the type. It is on a creek floodplain, making it similar to the river floodplain sites; but the presence of *U. americana*, *P. virginiana*, and other similarities, caused it to be included in the *U. americana* type.

The TWINSPAN classification of river floodplain sites mixes the *F. pennsylvanica*/*Symphoricarpos occidentalis* habitat type (Sites 30, 43, and 26) with the *Populus deltoides*/*Juniperus scopulorum* community type (Sites 4 and 29, excepting 13 and 21) and the *P. deltoides*/*F. pennsylvanica* community type (Sites 17 and 34). The woody understories were all similar, because the *P. deltoides* community types are seral to the *F. pennsylvanica*/*S. occidentalis* habitat type. Sites 13 and 21, early seral stages of this habitat type, were shown similar to the *J. scopulorum* sites and dissimilar to the *F. pennsylvanica* sites. The large amount of *J. scopulorum* (10–50%) and relatively small amount of *F. pennsylvanica* (0–1%) in the sapling layer was one cause of this exception.

Site 15 was dominated by *Pinus ponderosa* in the tree canopy; but TWINSPAN did not classify it as similar to the other *P. ponderosa* sites (Sites 9, 24, and 44). Site 15 compared to the other *Pinus* sites had less *P. ponderosa* (0–5% vs. 5–50%) and more *F. pennsylvanica* (5–10% vs. 0–2%) in the understory, and more *Prunus virginiana* in the shrub layer (5–10% vs. 0–2%) which accounted for this discrepancy. All sites dominated by *P. ponderosa* were classified as the *P. ponderosa*/*J. scopulorum* habitat type.

The *J. scopulorum/Oryzopsis micrantha* habitat type sites (Sites 12, 45, and 3) and the *P. flexilis/Agropyron spicatum* sites (Sites 46 and 47) were shown to be similar in the TWINSPAN classification.

DECORANA Ordination

DECORANA uses eigenvalues generated by reciprocal averaging of the species standard deviations (Gauch 1982). The actual numbers generated by DECORANA have no value; the importance lies in the relative distances between the sites. The greater the distance, the greater the dissimilarity. The total cover values of the species in the shrub and sapling layers were pooled to perform the ordination (similar to TWINSPAN).

The groupings of the subjective and TWINSPAN classifications have been superimposed on the DECORANA ordination as an additional check or comparison (fig. 7). DECORANA is not a classification technique, and these groupings were not generated by the DECORANA analysis.

The *Betula papyrifera/Clematis occidentalis* habitat type was at one end of the ordination. The *Quercus macrocarpa/Corylus* species habitat and community type sites were shown to be similar. Sites of the *Q. macrocar-*

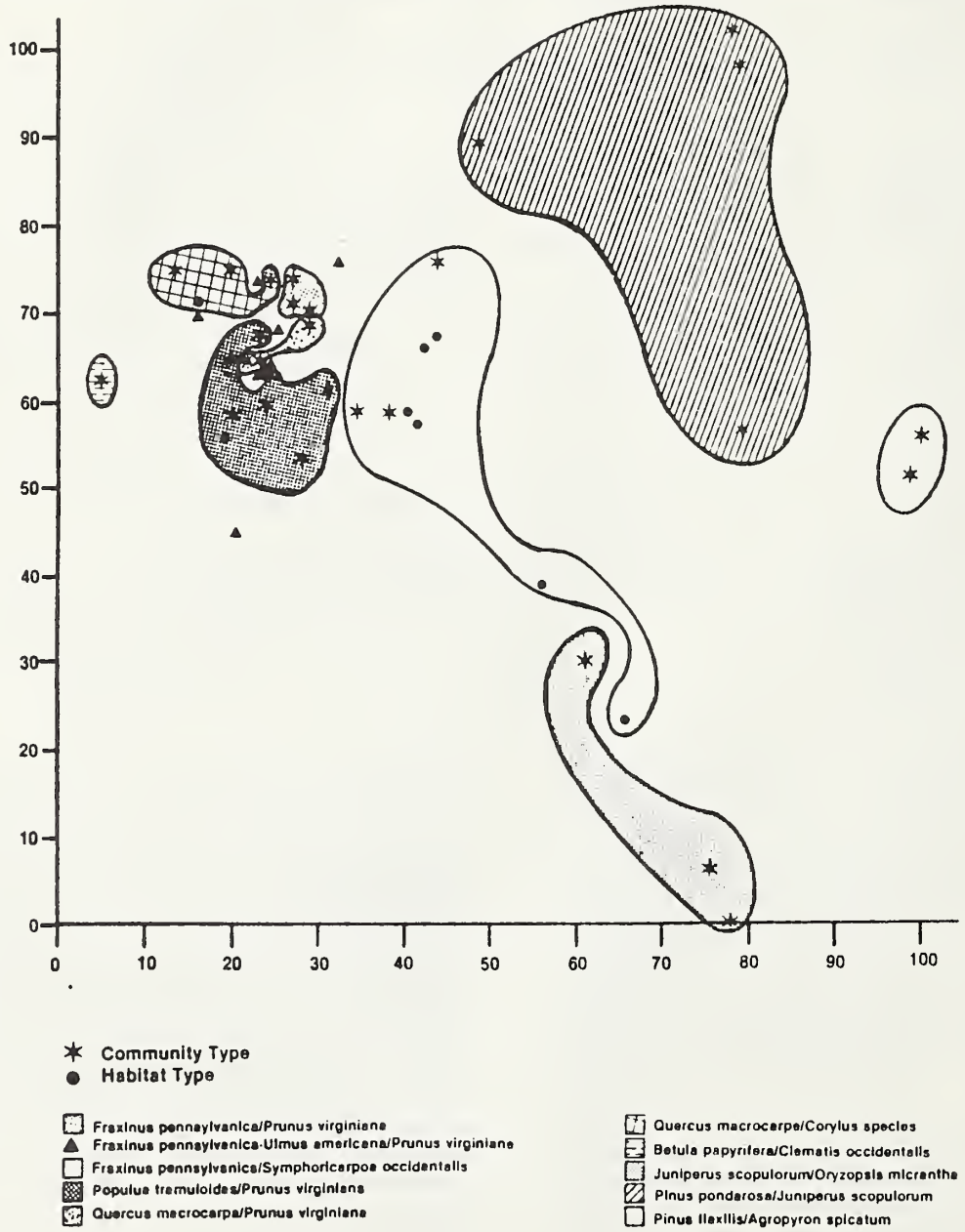

Figure 7.—Graph of the DECORANA ordination of total cover values for the shrub and sapling strata of woodland sites in southwestern North Dakota. Axis scales are in units of relativized average standard deviations of species turnover rates.

pa/Prunus virginiana habitat and community types also were close to each other on the DECORANA ordination.

The *Populus tremuloides/Prunus virginiana* sites were next on the ordination line. The woody understory of these sites was similar.

The *Fraxinus pennsylvanica/Prunus virginiana* habitat type sites were highly similar. *F. pennsylvanica/P. virginiana* habitat type *Ulmus americana* phase sites were not easily grouped; but the actual distance between sites was not great. The sites of the *F. pennsylvanica/ Symphoricarpos occidentalis* habitat type and community types were somewhat similar and were easily distinguished from other types.

Sites of the *Juniperus scopulorum/Oryzopsis micrantha* habitat type and the *Pinus ponderosa/J. scopulorum* habitat type were not very similar to each other, but were distinctly dissimilar to other types. *P. flexilis* sites were very similar to each other and distinct from other types.

Many of the sites which had understories dissimilar to other sites of the same habitat type in DECORANA also were dissimilar in TWINSPAN. The arrangement of sites along the ordination axis indicates a moisture gradient, as did the TWINSPAN results.

Use of the Classification

The Daubenmire habitat type classification method (Daubenmire 1952) was used to construct an ecological classification based on the potential natural woodland communities in southwestern North Dakota. The use of this classification is restricted to this area. Adjacent areas support "similar" vegetation, and some may have the same dominants and, therefore, the same habitat type names. However, there may be large floristic and species composition differences between different areas.

This study was concerned with relatively undisturbed communities, and is based on the potential climax plant association. Many of the woodlands exist at levels lower than this for a variety of reasons. The purpose of using only relatively undisturbed stands was to attempt to determine climax vegetation for the woodlands, and establishment of an ecological benchmark to enable comparisons of other woodlands. Therefore, this classification does not construct a comprehensive classification dealing with every existing cover type, regardless of condition and successional status. Rather, attempts have been made to describe the relatively undisturbed habitat and community types in enough detail that it will be possible to determine the correct habitat type for many disturbed woodlands.

Use of Woodland Key

The key was designed for identification of the different woodland habitat types in the field and is based on the presence or absence, and relative abundance of certain key species in a stand. The first key is to woodlands series, and the second is to the habitat and community types. The following ideas should be kept in mind when using the classification.

The following key was designed for use in native woodlands of southwestern North Dakota that have a mature tree canopy, are in relatively undisturbed condition, and have not been severely affected by grazing, logging, fire, etc. In native woodlands that have been severely disturbed, the habitat type can best be determined by extrapolation from a nearby undisturbed stand with similar site characteristics, or by comparing it to the habitat or community types listed for that tree series.

1. Locate the plot carefully where vegetation is most homogeneously distributed and representative of the entire stand.
2. Identify the dominant species and estimate their canopy cover values.
3. Identify the correct potential climax tree species in the Key to the Series.
4. Within the proper series, follow the habitat and community type key to determine the correct habitat or community type.
5. If difficulties in determining the correct type occur, refer to data in the type descriptions and appendices.
6. The key is not the classification. The determination must be validated with the description.

Key to Woodland Series

1. *Fraxinus pennsylvanica* or *Ulmus americana* or *Populus deltoides* 50–100% of the tree canopy ..... *Fraxinus pennsylvanica* Series
1. *Fraxinus pennsylvanica* or *Ulmus americana* or *Populus deltoides* not 50–100% of the tree canopy 2
   2. *Quercus macrocarpa* common in the understory woody layers ..... *Quercus macrocarpa* Series
   2. *Quercus macrocarpa* 0–2% or absent in the understory 3
3. *Populus tremuloides* 25–100% of the tree canopy and 5–100% in the understory ..... *Populus tremuloides* Series
3. *Populus tremuloides* not 50–100% of the overstory or understory 4
   4. *Pinus flexilis* present ..... *Pinus flexilis* Series
   4. *Pinus flexilis* not present 5
5. *Pinus ponderosa* 5–100% of the tree canopy ..... *Pinus ponderosa* Series
5. *Pinus ponderosa* not 5–100% of the tree canopy 6
   6. *Betula papyrifera* 25–100% in the overstory, *Clematis occidentalis* present in the herbaceous layer ..... *Betula papyrifera* Series
   6. *Juniperus scopulorum* 25–100% in the tree canopy *Thuidium abitinum* present in the herbaceous layer ..... *Juniperus scopulorum* Series

Key to Woodland Habitat and Community Types

Fraxinus pennsylvanica Series

1. *Fraxinus pennsylvanica* or *Ulmus americana* 50–100% of the tree canopy 2
1. *Populus deltoides* 25–100% of the tree canopy, on floodplains 4
   2. *Ulmus americana* present in the tree canopy, in upland drainages ..... *Fraxinus pennsylvanica/Prunus virginiana* Habitat Type, *Ulmus americana* Phase
   2. *Ulmus americana* not present in the tree canopy 3
3. *Prunus virginiana* 25–100% in the understory, in upland drainages ..... *Fraxinus pennsylvanica/Prunus virginiana* Habitat Type
3. *Prunus virginiana* 0–5% of the understory, and *Symphoricarpos occidentalis* 5–100% shrub cover on floodplains ..... *Fraxinus pennsylvanica/Symphoricarpos occidentalis* Habitat Type
   4. *Populus deltoides* 25–100% of the tree canopy, and *Fraxinus pennsylvanica* 25–100% of the understory ..... *Populus deltoides/Fraxinus pennsylvanica* Commmunity Type
   4. *Populus deltoides* 25–100% of the tree canopy, and *Juniperus scopulorum* 5–100% of the tree canopy ..... *Populus deltoides/Juniperus scopulorum* Community Type

Populus tremuloides Series

1. *Betula papyrifera* present ..... *Populus tremuloides/Betula papyrifera* Community Type
1. *Populus tremuloides* and *Prunus virginiana* present in the understory ..... *Populus tremuloides/Prunus virginiana* Habitat Type

Quercus macrocarpa Series

1. *Corylus* species 2–100% of the understory 2
1. *Corylus* species absent or less than 2% of the understory canopy 3
   2. *Quercus macrocarpa* 50–100% of the tree canopy ..... *Quercus macrocarpa/Corylus* species Habitat Type
   2. *Betula papyrifera* 50–100% of the tree canopy ... *Betula papyrifera/Corylus cornuta* Community Type
3. *Quercus macrocarpa* 50–100% of the tree canopy, and *Prunus virginiana* well represented in the understory ..... *Quercus macrocarpa/Prunus virginiana* Habitat Type
3. *Populus tremuloides* 25–100% of the tree canopy, *Quercus macrocarpa* present in the understory ..... *Populus tremuloides/Quercus macrocarpa* Community Type

Betula papyrifera Series

Betula papyrifera/Clematis occidentalis Habitat Type

Juniperus scopulorum Series

Juniperus scopulorum/Oryzopsis micrantha Habitat Type

Pinus ponderosa Series

Pinus ponderosa/Juniperus scopulorum Habitat Type

Pinus flexilis Series

Pinus flexilis/Agropyron spicatum Habitat Type

COMMUNITY DESCRIPTIONS

Vegetation data are arranged by strata for each of the two dominant woody species and the total for all species found in that strata. Information on the six dominant species of the herbaceous layer is listed. Dominance was determined using a combination of total cover, density, and constancy (percent of sites of equal size where the species was present).

The values given in the vegetation tables represent the species average of all stands in that type. Relative cover values are given in each description. Appendices A–E show a comparison of species presence and relative cover for each woody stratum of each stand of each habitat type.

Fraxinus pennsylvanica Series

Fraxinus pennsylvanica/Prunus virginiana Habitat Type

Distribution and Environment.—The *Fraxinus pennsylvanica/Prunus virginiana* habitat type occupied uplands where it formed long, often narrow, stringer draws (fig. 2). Its distribution followed the intermittent drainageways along draws, coulees, and valley bottoms. Topography is very important in the delineation of this habitat type. In areas where disturbances have occurred *P. virginiana* may not be present, causing the community to resemble the *F. pennsylvanica/Symphoricarpos occidentalis* habitat type. The potential natural vegetation

for upland drainages is the *F. pennsylvanica/P. virginiana* habitat type. The *F. pennsylvanica/S. occidentalis* habitat type is restricted to floodplains. The most homogeneous plant distribution occurred in the more level portions of the draws (0–5% slope), which was also where the communities tended to be the widest. Therefore, most plots were located in these areas. Most of these larger draws have small tributary, finger-like draws which join it (slopes ranged from 0 to approximately 40%). There were often scattered *F. pennsylvanica* trees in the center of these fingers, and the composition tended to be similar to the shrubby borders described later.

A shrubby border between the woodland and the grassland characterized this habitat type (fig. 8). The contact of these woody species with the grasslands forms a stairstep which goes from the shorter grass species to shrubby species of *Symphoricarpos occidentalis*, *Rosa woodsii*, *Rhus aromatica* and *Sheperdia argentea*; to the taller sapling species of *Prunus virginiana*, *P. americana*, *Amelanchier alnifolia* and *F. pennsylvanica*. The border then grades into the *F. pennsylvanica* woodland. Density of shrubs in the border appeared to be greater than that under the tree canopy. These are important habitats for many wildlife species because of their density, diversity, and biomass production. They are also important to the woodlands, because they create a shaded, moister microclimate which may foster the expansion of the woodlands and may decrease the speed of desiccating winds before they reach the woodland understory.

Soils.—The substrate of the *Fraxinus pennsylvanica/Prunus virginiana* habitat type is often unstable. Headward erosion in the uplands serves to expand some of the draws in this direction, and small slumps are often obvious on the side slopes. These areas are Entisols or Entisol intergrades such as Entic Haploborolls (Mack 1981, Butler et al. 1986). These habitat types are formed in an erosional topography along intermittent drainageways. The bottoms have been classified as Fluvaquentic Haploborolls (Butler et al. 1986).

Soil samples all had more than 35% clay. The textural classes were clay loam and silty clay in the upper sampling increments (0–60cm) and silty clay loam below. These unleached soils had pH values which were all 7.9 to 8.1, indicating $CaCO_3$ throughout the profile.

Vegetation.—The tree canopy of the *F. pennsylvanica/Prunus virginiana* habitat type was dominated by *F. pennsylvanica* which had a relative cover of 82% and a density of 492 trees/ha (table 4, fig. 9). *Acer negundo* was the only other species and contributed 18% relative cover, 58 trees/ha. Total density was 550 trees/ha.

Four sapling species were recorded: *F. pennsylvanica* was dominant with 51% relative cover and 1,408 saplings/ha, and *P. virginiana* was prevalent with 37% and 1,983 saplings/ha. These made up the bulk of the total density of 3,749 saplings/ha. *P. americana* and *Amelan-*

Table 4.—Vegetation data, by stratum, for the dominant species of the *Fraxinus pennsylvanica/Prunus virginiana* habitat type, in native woodlands of southwestern North Dakota.[1]

Species	Den /ha	Rel cover	Con
		(percent)	(percent)
TREE			
Acer negundo	58	18	33
Fraxinus pennsylvanica	492	82	100
Total 2 species	550	100	
SAPLING			
Fraxinus pennsylvanica	1408	51	100
Prunus virginiana	1983	37	100
Total 4 species	3749	100	
SHRUB			
Prunus virginiana	46776	66	100
Symphoricarpos occidentalis	82305	27	100
Total 7 species	140192	100	
HERBACEOUS			
Fraxinus pennsylvanica		3.7	100
Galium boreale		7.3	100
Lactuca oblongifolia		5.2	100
Poa pratensis		20	100
Prunus virginiana		7.8	100
Symphoricarpos occidentalis		15	100
Total 48 species			

[1]*Rel = relative, Den = density, Con = constancy, ha = hectare*

Figure 8.—Exterior of the *Fraxinus pennsylvanica/Prunus virginiana* habitat type.

Figure 9.—Interior of the *Fraxinus pennsylvanica/Prunus virginiana* habitat type.

chier alnifolia made minor contributions to canopy coverage.

P. virginiana dominated the shrub stratum with an average of 66% relative cover and 46,776 stems/ha; *Symphoricarpos occidentalis* was also important, providing 27% relative cover and 82,305 stems/ha; and *F. pennsylvanica* had 3% and 3,841 stems/ha. Four additional species were encountered but provided 1% or less of the relative cover. Total density was 140,192 stems/ha.

The presence of *F. pennsylvanica* in all three woody layers illustrates its successful reproduction and capacity to continue to dominate this plant association. *Ulmus americana* was not present in any of the stands, which is an important characteristic to distinguish this habitat type from the *F. pennsylvanica/P. virginiana* habitat type *U. americana* phase.

A total of 48 species were sampled in the herbaceous canopy. Relative cover values for the dominant species were: *Poa pratensis*, 20%; *S. occidentalis*, 15%; *Prunus virginiana*, 7.8%; *Galium boreale*, 7.3%; *Lactuca oblongifolia*, 5.2%; and *F. pennsylvanica*, 3.7%. These species had 100% constancy. *Arctium minus* with 12% relative cover and *Galium aparine* with 7.4% were present in 67% of the sites.

Other Studies.—Hansen et al. (1984) described a *F. pennsylvanica/P. virginiana* habitat type which often had *Ulmus americana* as a codominant in Theodore Roosevelt National Park, North Dakota. Hansen (1985) described the same habitat type for southeastern Montana and northwestern South Dakota. Nelson (1961), Wali et al. (1980), Mack (1981), and Butler et al. (1986) described *F. pennsylvanica* woodlands in central and western North Dakota.

Fraxinus pennsylvanica/Prunus virginiana Habitat Type *Ulmus americana* Phase

Distribution and Environment.—The *Fraxinus pennsylvanica/Prunus viginiana* habitat type *Ulmus americana* phase is similar to the *F. pennsylvanica/P. virginiana* habitat type in most respects, and is easily distinguished by the presence of *U. americana*. *U. americana* is a codominant in all three woody strata, and has been included as a phase of the *F. pennsylvanica/P. virginiana* habitat type. This phase is most prevalent in McKenzie County and in northern Golden Valley County. These sites appear to be more mesic than the *F. pennsylvanica/P. virginiana* habitat type to the south. The phase of *U. americana* occupies a number of different topographic positions. It is found in uplands along intermittent drainageways, streams and intermittent streams, while some occupy north-facing slopes (fig. 10).

Soils, topography, erosional processes, and the shrubby border, which characterize the *F. pennsylvanica/P. virginiana* habitat type, are similar to the upland stands of this phase. Those along intermittent streams are also similar, except the stream sites that had higher moisture conditions and well defined channels. The slopes were nearly level for many of the sites, while those on north-facing slopes had gentle slopes of about 8%. Slopes may reach 40% in some instances.

Figure 10.—Exterior of the *Fraxinus pennsylvanica/Prunus virginiana* habitat type *Ulmus americana* phase.

The status of these communities is somewhat tenuous because of Dutch Elm disease. The disease is present in southwestern North Dakota; but many of the trees have not yet been infected. If the trees become infected, the nature of many of these woodlands may change. At present, *U. americana* is prevalent in all three woody canopies. Dutch Elm often only inflicts older trees, and it appears that as the more mature trees die there will be reproduction of *U. americana* in the understory. This may ensure *U. americana*'s continued presence in this phase, although its ability to continue as a codominant is questionable.

Soils.—Soils of the *Fraxinus pennsylvanica/Prunus virginiana* habitat type *Ulmus americana* phase were loams at the surface (0-15 cm) and silt loams deeper. The texture was silt loam from 15 to 60 cm. At 61 cm clay content increased, shifting the texture to a silty clay loam to 75 cm and a clay loam to 90 cm. The pH increased with depth from a low of 7.4 at the surface to 8.1 at 90 cm, indicating some leaching has occurred in the surface increments.

Vegetation.—The overstory of the *Fraxinus pennsylvanica/Prunus virginiana* habitat type *Ulmus americana* phase had the greatest species richness of the *F. pennsylvanica* series. Relative cover for *F. pennsylvanica* was 61% (432 trees/ha); and *U. americana* was 29% (211 trees/ha) (table 5, fig. 11). Five tree species and 700 trees/ha were encountered in this habitat type.

Sapling diversity was also the highest of this series—12 species. *F. pennsylvanica* was the cover dominant with 18% average cover, 364 saplings/ha; *Prunus virginiana* was second having 28% and 1,214 saplings/ha; and *U. americana* was third with 23% and 214/ha. Total density was 2,311 saplings/ha.

Fourteen shrub species had 2% total density of 94,534 stems/ha. *P. virginiana* was dominant with 51% relative cover and 32,687 stems/ha followed by *Symphoricarpos occidentalis* with 16% cover at 28,101 stems/ha.

Diversity of the herbaceous layer was high; a total of 80 species were encountered in this plant association. *Carex* spp. (predominantly *Carex sprengelii*) were present in all stands and had a relative cover of 19%. *P. virginiana* had relative cover of 10%, followed by: *S. occiden-*

talis, 5.7%; *F. pennsylvanica*, 5.1%; *Smilacina stellata*, 3.9%; and *Fragaria vesca*, 2.8%. These species were present in 86% of the sample stands.

Fraxinus pennsylvanica/Symphoricarpos occidentalis Habitat Type

Distribution and Environment.—The *Fraxinus pennsylvanica/Symphoricarpos occidentalis* habitat type is found on nearly level floodplains and lower terraces of the Little Missouri River and its major tributaries (fig. 12). This habitat type is usually found away from the river on the older, stabilized floodplains. Topography is important in the distribution of this habitat type. On old, stabilized floodplains where the watertable is relatively deep, *Prunus virginiana* may become established, causing it to resemble the *F. pennsylvanica/P. virginiana* habitat type. However, *P. virginiana* seldom becomes a dominant canopy on the floodplains. The potential natural vegetation for floodplains is *F. pennsylvanica/S. occidentalis*, and for upland drainages, *F. pennsylvanica/P. virginiana*.

Table 5.—Vegetation data, by stratum, for the dominant species of the *Fraxinus pennsylvanica/Prunus virginiana* habitat type *Ulmus americana* phase, in native woodlands of southwestern North Dakota.[1]

Species	Den /ha	Rel cover	Con
		(percent)	(percent)
TREE			
Fraxinus pennsylvanica	432	82	100
Ulmus americana	211	29	100
Total 5 species	700	100	
SAPLING			
Fraxinus pennsylvanica	364	29	100
Prunus virginiana	1214	28	100
Total 12 species	2311	100	
SHRUB			
Prunus virginiana	32687	51	86
Symphoricarpos occidentalis	28101	16	100
Total 14 species	94534	100	
HERBACEOUS			
Carex spp.		19	100
Fragaria vesca		2.8	86
Fraxinus pennsylvanica		5.1	86
Prunus virginiana		10	86
Smilacina stellata		3.9	86
Symphoricarpos occidentalis		5.7	86
Total 48 species			

[1] *Rel = relative, Den = density, Con = constancy, ha = hectare*

Figure 11.—Interior of the *Fraxinus pennsylvanica/Prunus virginiana* habitat type *Ulmus americana* phase.

Figure 12.—Exterior of the *Fraxinus pennsylvanica/Symphoricarpos occidentalis* habitat type.

Proceeding toward the river under the forest canopy, the *Populus deltoides/F. pennsylvanica* community type and then the *P. deltoides/Juniperus scopulorum* community type are encountered. These types sometimes are referred to as gallery forests or riparian areas. *Artemisia cana/Agropyron smithii* is another habitat type often encountered on these floodplains (Hansen et al. 1984).

The Little Missouri River is a meandering river which removes sediments from its cut bank and deposits sediments on its accretion slope. As the course of the river changes, the accretion slope may later become the cut bank and vice versa. *P. deltoides* frequently colonizes the fresh alluvial deposits on the accretion slope; but it is a seral species intolerant of competition. Following *P. deltoides* establishment, *J. scopulorum* becomes evident in the understory. As time progresses, the microclimate and soil environment improve and *F. pennsylvanica* enters and eventually dominates this habitat type. The time span covered by *P. deltoides* establishment until its replacement by *F. pennsylvanica* is estimated to take approximately 100 years, based on tree core information.

Soils.—Clay content of the soils of the *Fraxinus pennsylvanica/Symphoricarpos occidentalis* habitat type ranged from 30–59% and clay or silty clay textures dominate these composite profiles. The pH was an alkaline 8.0 to 8.3 which indicates $CaCO_3$ throughout the profile and an unleached condition.

Vegetation.—The *Fraxinus pennsylvanica/Symphoricarpos occidentalis* habitat type contained only two tree species: *F. pennsylvanica* with a relative coverage of 98% at 500 trees/ha, and *Juniperus scopulorum* with 2% and 17 trees/ha (table 6, fig. 13). Total density was 517

trees/ha. Although none were sampled in the macroplots, widely scattered decadent *P. deltoides* were present in the communities.

Six species were present in the sapling layer which had 1708 saplings/ha. *F. pennsylvanica* had 90% relative cover with 1,525 saplings/ha, followed by *Cornus stolonifera* with 6% and 75 saplings/ha.

S. occidentalis had 65% relative cover in the shrub canopy and 110,837 stems/ha; *Rosa woodsii* was the second dominant with 19% relative cover, 24,554 stems/ha. *F. pennsylvanica* exhibited good reproduction with 10% of the cover and 4,390 stems/ha. A total of seven species were sampled in the shrub stratum of this association, which had 146,914 stems/ha.

Table 6.—Vegetation data, by stratum, for the dominant species of the *Fraxinus pennsylvanica/Symphoricarpos occidentalis* habitat type, in native woodlands of southwestern North Dakota.[1]

Species	Den /ha	Rel cover	Con
		(percent)	(percent)
TREE			
Fraxinus pennsylvanica	500	98	100
Juniperus scopulorum	17	2	33
Total 2 species	517	100	
SAPLING			
Cornus stolonifera	75	6	100
Fraxinus pennsylvanica	1525	90	33
Total 6 species	1708	100	
SHRUB			
Rosa woodsii	76	19	100
Symphoricarpos occidentalis	82305	65	100
Total 7 species	146914	100	
HERBACEOUS			
Fraxinus pennsylvanica		3.0	100
Poa pratensis		21	67
Rosa woodsii		5.9	67
Symphoricarpos occidentalis		18	100
Taraxacum officinale		1.7	100
Thalictrum dasycarpum		3	100
Total 43 species			

[1] *Rel = relative, Den = density, Con = constancy, ha = hectare*

Figure 13.—Interior of the *Fraxinus pennsylvanica/Symphoricarpos occidentalis* habitat type.

A total of 43 species were sampled in the herbaceous canopy. Relative cover values for species with 100% constancy were: *S. occidentalis*, 18%; *F. pennsylvanica*, 3.0%; *Thalictrum dasycarpum*, 3%; and *Taraxacum officinale*, 1.7%. *Poa pratensis* and *Rosa woodsii* were important species having 67% constancy and 21% and 5.9% relative cover, respectively.

Other Studies.—This habitat type has been described by Hansen et al. (1984) for Theodore Roosevelt National Park, North Dakota. Nelson (1961) and Wali et al. (1980) have described floodplain vegetation dominated by *F. pennsylvanica* and *Populus deltoides*.

Populus deltoides/Fraxinus pennsylvanica Community Type

Distribution and environment.—The *Populus deltoides/Fraxinus pennsylvanica* community type dominance is limited to the floodplains of the Little Missouri River (fig. 14). Establishment is most successful on fresh alluvial deposits of sands, silts, or clays. *P. deltoides* on these fresh deposits are free from competition with an herbaceous understory for moisture, or a tree canopy for sunlight.

These communities are seral, and the vegetation data show they are being replaced by *F. pennsylvanica*. This community type is considered to be one of the mid-successional stages found on the older, more stable areas on the floodplains. The *P. deltoides/Juniperus scopulorum* community type is an earlier stage found on the younger sites. If undisturbed, the *P. deltoides/F. pennsylvanica* community type will eventually result in the *F. pennsylvanica/Symphoricarpos occidentalis* habitat type.

Soils.—Soils of the *Populus deltoides/Fraxinus pennsylvanica* community type are formed in alluvium on the floodplains and low terraces of the Little Missouri River. These deposits are the result of over-the-bank flooding and meandering of the Little Missouri River. Changes in the volume and rate of the flow of the river affect the deposition of sediments resulting in layers of different particle sizes.

Figure 14.—Exterior of the *Populus deltoides/Fraxinus pennsylvanica* community type.

The soil textural classes range from silty clay loam, clay loam, clay and loam. The pH was lowest at the surface (8.0) but fairly consistent (8.2–8.3) throughout the rest of the profile indicating $CaCO_3$ presence and unleached conditions.

Vegetation.—The *Populus deltoides/Fraxinus pennsylvanica* community type was dominated in the tree canopy by *P. deltoides* having 77% relative cover (table 7, fig. 15). In very early successional stages, saplings are densely packed; but as the community matures, the successful trees are widely spaced (150 trees/ha). *F. pennsylvanica* at 16% relative cover (188 trees/ha) and *Juniperus scopulorum* with 7% and 125 trees/ha were the only other species contributing to the canopy of this layer, which had 293 trees/ha.

Table 7.—Vegetation data, by stratum, for the dominant species of the *Populus deltoides/Fraxinus pennsylvanica* community type, in native woodlands of southwestern North Dakota.[1]

Species	Den /ha	Rel cover	Con
		(percent)	(percent)
TREE			
Fraxinus pennsylvanica	188	16	100
Populus deltoides	150	77	100
Total 3 species	293	100	
SAPLING			
Fraxinus pennsylvanica	1050	84	100
Juniperus scopulorum	88	8	100
Total 5 species	1097	100	
SHRUB			
Rosa woodsii	36420	37	100
Symphoricarpos occidentalis	81893	41	100
Total 9 species	140537	100	
HERBACEOUS			
Fraxinus pennsylvanica		5.9	100
Melilotus officinalis		20	100
Rosa woodsii		12	100
Smilacina stellata		5.3	100
Symphoricarpos occidentalis		21	100
Thalictrum venulosum		6.4	100
Total 38 species			

[1] *Rel = relative, Den = density, Con = constancy, ha = hectare*

Figure 15.—Interior of the *Populus deltoides/Fraxinus pennsylvanica* community type.

P. deltoides was not present in the sapling layer. *F. pennsylvanica* dominated with 84% relative cover and a density of 1,050/ha. *J. scopulorum* was also present but much less abundant at 8% relative cover and 88 saplings/ha. Other species present were *Rhus aromatica*, *Acer negundo* and *Salix* spp. Total density was 1,097 saplings/ha.

Nine species were encountered in the shrub layer. Common species were *Symphoricarpos occidentalis*, 41% relative cover, 81,893 stems/ha; *Rosa woodsii*, 37% cover, 36,420 stems/ha; and *F. pennsylvanica*, 19% cover, 20,165 stems/ ha. The total density was relatively high at 140,537 stems/ha.

The presence and importance of *F. pennsylvanica* in all three woody strata is significant. It indicates the seral nature of *P. deltoides* and its gradual replacement in the overstory.

This community type had a total of 38 species in the herbaceous canopy. The following species had the greatest relative cover and were present in 100% of the sites sampled: *S. occidentalis*, 21%; *Melilotus officinalis*, 20%; *Rosa woodsii*, 12%; *Thalictrum venulosum*, 6.4%; *F. pennsylvanica*, 5.9%; and *Smilacina stellata*, 5.3%. Graminoid species were relatively unimportant; *Carex* spp. and *Elymus canadensis* were present in all stands and had 1.9% and 2.2% relative cover, respectively.

Populus deltoides/Juniperus scopulorum Community Type

Distribution and Environment.—The characteristics of the *Populus deltoides/Juniperus scopulorum* community type are similar to those of the *P. deltoides/Fraxinus pennsylvanica* community type. The dominance of *J. scopulorum* indicates that it is a younger seral stage which will gradually grade into the *P. deltoides/F. pennsylvanica* community type and eventually the *F. pennsylvanica/ Symphoricarpos occidentalis* habitat type (fig. 16). This community type is found nearer the river on more recent alluvial deposits.

Soils.—Soils of the *Populus deltoides/Juniperus scopulorum* community type have developed in alluvial

Figure 16.—Exterior of the *Populus deltoides/Juniperus scopulorum* community type.

deposits laid down by the Little Missouri River on the broad, level floodplains. The texture was consistently silt loam from 0–60 cm. Sand increased from 61–90 cm shifting the texture from a silt to a sandy loam. These soils have a very high available water holding capacity. The pH gradually increased with depth from 7.9 to 8.4. These soils do not appear to be leached.

Vegetation.—Three species were recorded in the tree canopy of the *Populus deltoides/Juniperus scopulorum* community type: *P. deltoides* with 75% relative cover (188 trees/ha), *J. scopulorum* 24% (325/ha), and *Fraxinus pennsylvanica* 1% (25/ha) (table 8, fig. 17). Total density was 538 trees/ha. No *P. deltoides* was observed in any of the other strata.

Table 8.—Vegetation data, by stratum, for the dominant species of the *Populus deltoides/Juniperus scopulorum* community type, in native woodlands of southwestern North Dakota.[1]

Species	Den /ha	Rel cover	Con
		(percent)	(percent)
TREE			
Juniperus scopulorum	325	24	100
Populus deltoides	188	75	100
Total 3 species	538	100	
SAPLING			
Fraxinus pennsylvanica	106	19	100
Juniperus scopulorum	213	63	75
Total 4 species	376	100	
SHRUB			
Fraxinus pennsylvanica	11523	18	100
Symphoricarpos occidentalis	70062	54	100
Total 9 species	104424	100	
HERBACEOUS			
Elymus canadensis		2.4	100
Fraxinus pennsylvanica		3.1	100
Melilotus officinalis		13	100
Symphoricarpos occidentalis		15	100
Thalictrum dasycarpum		2.3	100
Toxicodenderon rydbergii		12	100
Total 53 species			

[1] *Rel = relative, Den = density, Con = constancy, ha = hectare*

Figure 17.—Interior of the *Populus deltoides/Juniperus scopulorum* community type.

J. scopulorum dominated the sapling canopy with 63% relative cover and a density of 213 saplings/ha. *F. pennsylvanica* composed 19% of the relative cover and its density was 106 saplings/ha. Four species were recorded in this layer which had 376 saplings/ha.

Nine species were sampled in the shrub stratum. Dominants were *Symphoricarpos occidentalis* with 54% relative cover, 70,062 stems/ha; and *F. pennsylvanica* at 18% with 11,523 stems/ha. *Rosa woodsii* was also significant having 11% cover and 10,802 stems/ha. The total density was 104,424 stems/ha.

The prevalence of *J. scopulorum* decreased in each of the lower canopies while that of *F. pennsylvanica* increased. The success of *F. pennsylvanica* indicates that it will eventually replace those species with less successful reproduction (*P. deltoides* and *J. scopulorum*) in the tree and sapling canopy.

A total of 53 species was encountered in the herbaceous canopy. *S. occidentalis* dominated having 15% relative cover, followed by: *Melilotus officinalis*, 13%; and *Toxicodendron rydbergii*, 12%. These species, along with *F. pennsylvanica* at 3.1% relative cover, *Elymus canadensis*, 2.4%, and *Thalictrum dasycarpum*, 2.3%, had 100% constancy.

Populous tremuloides Series

Populous tremuloides/Prunus virginiana Habitat Type

Distribution and Environment.—The distribution of the *Populus tremuloides/Prunus virginiana* habitat type (fig. 18) ranges throughout southwestern North Dakota, but is much more common in McKenzie County than in the southern counties. A frequent topographic position is in the uplands at the crown of the *Fraxinus pennsylvanica/Prunus virginiana* habitat type *Ulmus americana* phase.

This crown is usually on gentle slopes (0-20%), but slopes are as steep as 45% in some instances. Grasslands occupy the summit and shoulder topographic positions and grade into the *Populus tremuloides/Prunus virginiana*

Figure 18.—Exterior of the *Populus tremuloides/Prunus virginiana* habitat type.

habitat type on the shoulder and backslope. Downslope, the drainage is more defined, becoming a draw or coulee and often classifies as the *F. pennsylvanica/P. virginiana* habitat type *U. americana* phase. The lower crown/draw border shows a mixture of *F. pennsylvanica* and *Populus tremuloides* in the tree canopy and many shrub and sapling species which are common to both habitat types. The grassland/crown border often is composed of densely packed saplings of *P. tremuloides*.

Because *P. tremuloides* often is a seral species, the *F. pennsylvanica/Prunus virginiana* habitat type *U. americana* phase may eventually replace it. This is a definite possibility, because the border areas appear to be quite dynamic, although this would be a very long-term process. There is an obvious difference between these communities; therefore, they have been classified as different habitat types.

The occurrence of the *Populus tremuloides/Prunus virginiana* habitat type at the top of north-facing slopes may make it the potential for these topographic positions. This position results in increased snow catch as the winds blow across the top of other buttes, while the downslope portions are more sheltered. In the spring, the soils of these crowns sometimes remain frozen after the frost has gone out downslope. Spring is a critical germination time for tree species, and *P. tremuloides* may compete better in these wet, cold soils because of its ability to reproduce by sprouting.

Another much less common position is on upland drainageways where *P. tremuloides* lines the banks. *F. pennsylvanica* also is present; but the moist soil conditions and volume of water which drains through them tends to cause unstable soil conditions and favors *P. tremuloides*. *P. tremuloides* may serve to stabilize these areas which may eventually result in the *F. pennsylvanica/Prunus virginiana* habitat type *U. americana* phase. It is impossible to make accurate predictions at this time, and it appears that *P. tremuloides* will persist and dominate these sites for some time into the future.

A common characteristic of this habitat type is to have the more mature trees centrally located and get progressively younger with distance away from the center in a concentric age distribution pattern. As the mature trees die, the canopy opens and root suckers are produced to "recolonize" the opening. The ability to root sucker results in a stand often being a clone of one or a few trees.

Soils.—The soil texture of the *Populus tremuloides/Prunus virginiana* habitat type was loam through the profile. These soils show leaching to a depth of 46 cm, but would still classify as a Mollisol. Some of the more erosional sites may be Inceptisols. The pH increased with depth from 7.2 to 8.0. The increase in pH at 46 cm represents $CaCO_3$ below this point.

Vegetation.—The *Populus tremuloides/Prunus virginiana* habitat type was dominated by *P. tremuloides* with 73% relative cover and a density of 597 trees/ha (table 9, fig. 19). It was associated with *Fraxinus pennsylvanica* having 14% cover and 79 trees/ha. Density was 722 trees/ha.

There were 12 species of saplings, but two species clearly dominated the canopy: *P. tremuloides* had 39% mean cover at 896 saplings/ha and *F. pennsylvanica* 33% at 557 saplings/ha. There were 2,304 saplings/ha.

Table 9.—Vegetation data, by stratum, for the dominant species of the *Populus tremuloides/Prunus virginiana* habitat type, in native woodlands of southwestern North Dakota.[1]

Species	Den /ha	Rel cover	Con
		(percent)	(percent)
TREE			
Fraxinus pennsylvanica	79	14	100
Populus tremuloides	597	73	100
Total 5 species	722	100	
SAPLING			
Fraxinus pennsylvanica	557	33	86
Populus tremuloides	896	39	100
Total 12 species	2304	100	
SHRUB			
Amelanchier alnifolia	11111	16	100
Prunus virginiana	21928	34	100
Total 17 species	81717	100	
HERBACEOUS			
Amelanchier alnifolia		3.9	100
Galium boreale		4.2	100
Prunus virginiana		12	100
Smilacina stellata		4.8	100
Symphoricarpos occidentalis		15	100
Toxicodenderon rydbergii		6.6	86
Total 71 species			

[1] *Rel = relative, Den = density, Con = constancy, ha = hectare*

Figure 19.—Interior of the *Populus tremuloides/Prunus virginiana* habitat type.

Diversity in the shrub component was the richest of all habitat types—17 species. *Prunus virginiana* contributed 34% relative cover (21,928 stems/ha) and *Amelanchier alnifolia* 13% (11,111 stems/ha). There was a total of 81,717 stems/ha.

Herbaceous diversity was high also, with 71 species present. Dominant species and their relative cover values were: *Symphoricarpos occidentalis*, 15%; *P. virginiana*, 12%; *Toxicodenderon rydbergii*, 6.6%; *Smilacina stellata*, 4.8%; *Galium boreale*, 4.2%; and *A. alnifolia*, 3.9%. All species had a constancy of 100%, except *T. rydbergii* which had 86%. Graminoid species were not significant contributors to the herbaceous canopy.

Other Studies.—Hansen et al. (1984) described a *P. tremuloides/Betula occidentalis* habitat type for Theodore Roosevelt National Park, North Dakota, which appears to be very similar to this *P. tremuloides/P. virginiana* habitat type. Wali et al. (1980) and Mack (1981) have described *P. tremuloides* communities in central and western North Dakota.

Quercus macrocarpa Series

Quercus macrocarpa/Prunus virginiana Habitat Type

Distribution and Environment.—The *Quercus macrocarpa/Prunus virginiana* habitat type was located in upland situations following intermittent streams (fig. 20). The toe and foot slopes were dominated by *F. pennsylvanica* where the soils were more mesic. The gently sloping backslopes (approximately 13%) appeared drier, covered a much greater surface area, and were dominated by *Q. macrocarpa*. *F. pennsylvanica* was present in the understory in relatively large amounts; but few seemed to survive and contribute to the tree canopy. *Q. macrocarpa* appears to be the better competitor on the somewhat drier sites, and therefore the potential climax dominant. *Q. macrocarpa* may be modifying the site, making it more mesic and more favorable to the success of *F. pennsylvanica*. The suppression of fire also may influence this habitat type. Thin black soil horizons, indicative of fire, were found in the soils. *Q. macrocarpa* is more fire tolerant than *F. pennsylvanica*; therefore, suppression of fire may favor *F. pennsylvanica*. These are very long-term processes, and impossible to predict at present.

The *Q. macrocarpa/P. virginiana* habitat type occupied similar topographical positions, tended to follow drainageways, and had a shrubby border similar to the *F. pennsylvanica/P. virginiana* habitat type. There were several differences. The *Q. macrocarpa/P. virginiana* habitat type distribution was limited to northeast McKenzie County, and the size of the individual communities was much larger than those dominated by *F. pennsylvanica*. The composition of the shrubby border which extended approximately 1-3 m along the grassland interface contained: *Q. macrocarpa*, *F. pennsylvanica*, *P. virginiana*, *Amelanchier alnifolia*, and *Elaeagnus argentea*.

Soils.—The *Quercus macrocarpa/Prunus virginiana* habitat type was restricted to the northeast portions of McKenzie County which had been glaciated. Soils of this habitat type had a loam texture at depths of 0–30 cm. Clay content increased from 30–90 cm, and texture was a clay loam. The pH ranged from 7.0 at the surface to 8.2 at 75–90 cm. These soils were leached to a depth of 75 cm.

Table 10.—Vegetation data, by stratum, for the dominant species of the *Quercus macrocarpa/Prunus virginiana* habitat type, in native woodlands of southwestern North Dakota.[1]

Species	Den /ha	Rel cover	Con
		(percent)	(percent)
TREE			
Fraxinus pennsylvanica	150	21	100
Quercus macrocarpa	838	77	100
Total 3 species	1001	100	
SAPLING			
Fraxinus pennsylvanica	138	27	100
Quercus macrocarpa	313	49	100
Total 7 species	910	100	
SHRUB			
Amelanchier alnifolia	14815	28	100
Prunus virginiana	22634	23	100
Total 9 species	98148	100	
HERBACEOUS			
Amelanchier alnifolia		4.9	100
Carex spp.		14	100
Fraxinus pennsylvanica		11	100
Galium boreale		10	100
Prunus virginiana		11	100
Symphoricarpos occidentalis		8.1	100
Total 44 species			

[1] *Rel = relative, Den = density, Con = constancy, ha = hectare*

Figure 20.—Exterior of the *Quercus macrocarpa/Prunus virginiana* habitat type.

Figure 21.—Interior of the *Quercus macrocarpa/Prunus virginiana* habitat type.

Vegetation.—In the *Quercus macrocarpa/Prunus virginiana* habitat type, *Q. macrocarpa* was the dominant overstory species, covering an average of 77% of the area and having a density of 838 trees/ha; *Fraxinus pennsylvanica* was present with 21% relative cover and 150 trees/ha (table 10, fig. 21). *Populus tremuloides* presence was limited: 1% relative cover and 13 trees/ha. Total density was 1,001 trees/ha.

In the sapling layer, there were seven species with an average total density of 910 saplings/ha. Again, *Q. macrocarpa* was dominant with 49% relative cover and 313 saplings/ha, and *F. pennsylvanica* was present with 27% and 138 saplings/ha.

Nine species were found in the shrub layer. *Amelanchier alnifolia* had 28% mean cover with 14,815 stems/ha; *Prunus virginiana* had 23% cover with 22,634 stems/ha. Total density was 98,148 stems/ha.

A total of 44 different herbaceous species were sampled. Relative cover values for the dominants were: *Carex* spp., 14% (predominantly *C. sprengelii*); *F. pennsylvanica*, 11%; *P. virginiana*, 11%; *Galium boreale*, 10%; *S. occidentalis*, 8.1%; and *A. alnifolia*, 4.9%. All species listed had 100% constancy.

Other Studies.—No other studies have recognized a *Q. macrocarpa/P. virginiana* habitat type. Wali et al. (1980) has described *Q. macrocarpa* communities in western North Dakota.

Quercus macrocarpa/Corylus species Habitat Type

Distribution and Environment.—The *Quercus macrocarpa/Corylus* species habitat type is found in the Killdeer Mountains (fig. 22) and Lone Butte areas. Topography, microclimate, soils, and vegetation of the Killdeer Mountains form a unique "island" which rises above the prairie. The Lone Butte area is more characteristic of Badlands topography; but some areas are heavily wooded, and it is near the Killdeer Mountains. Slopes ranged from nearly level to 30%.

There are many legends of native American presence in the Killdeer Mountains, and the forests may have been impacted by their activities. The timber was also a valuable and important resource for the settlers of this region. A severe fire in 1913 also had a major influence on the development of the vegetation (Wali et al. 1980). The combination of these factors makes it difficult to determine and then to locate "undisturbed" stands to sample.

Figure 22.—Exterior of the *Quercus macrocarpa/Corylus* species habitat type.

The *Q. macrocarpa/C.* species association may eventually predominate through much of the Killdeers. However, certain specific environmental conditions may favor other habitat types. One very restricted habitat type is *Betula papyrifera/Clematis occidentalis* on north-facing slopes. Another probable habitat type would be a *Populus tremuloides/Corylus* species plant association; however, no data were collected to substantiate this type. Included as a community type under this habitat type is *B. papyrifera/Corylus cornuta* community type. The occurrence of this community type appears to be related to disturbance; but it is possible that there is a unique combination of factors present that would favor this combination as climax.

Soils.—Soil texture of the *Quercus macrocarpa/Corylus* species habitat type is sandy loam throughout most of the profile and shows an Argillic horizon at 31–45 cm. The pH values were relatively low, 7.0 to 7.5, and increased with depth indicating leaching.

Vegetation.—The *Quercus macrocarpa/Corylus* species habitat type was dominated by *Q. macrocarpa* with 77% relative cover at 517 trees/ha, and was associated with *Fraxinus pennsylvanica* at 18% and 108 trees/ha (table 11, fig. 23). Total density was 659 trees/ha.

There were a total of 10 sapling species with a total density of 1,993 saplings/ha. *Amelanchier alnifolia* with 20% relative cover and 425 saplings/ha, and *Prunus virginiana* with 18% relative cover and 517 saplings/ha were dominant in the sapling canopy. *Q. macrocarpa* and *C. cornuta* were also important species, having 18% relative cover with 125 saplings/ha and 14% relative cover with 517 saplings/ha, respectively.

In the shrub canopy, there were 12 species with 88,477 stems/ha. *P. virginiana* dominated with 52% relative cover and 31,550 stems/ha, followed by *C. cornuta* and *U. americana* with 17% relative cover and 7,681 stems/ha.

In the herbaceous canopy there was a total of 42 species recorded. *Carex* spp. were dominant having 23% relative cover, followed by: *Symphoricarpos occidentalis*, 17%; *Galium boreale*, 4.5%; and *Apocynum androsaemilfolium*, 3.7%, all of which had 100% constancy. *Aralia nudicaulis* with 4.2% relative cover and *Schizachne purpurascens* with 3.9% cover had 67% constancy.

Other Studies.—No other studies have described a *Q. macrocarpa/Corylus* species habitat type. Wali et al. (1980) has described *Q. macrocarpa* communities in the Killdeer Mountains, North Dakota.

Juniperus scopulorum Series

Juniperus scopulorum/Oryzopsis micrantha Habitat Type

Distribution and Environment.—*Juniperus scopulorum* trees can be found scattered throughout the Little

Missouri National Grasslands on butte tops, ridges, rocky outcrops, intermingled in the understory of other habitat types, or in "savanna" like communities in coves. However, habitat types dominated by *J. scopulorum* are confined to steep scoria and shale slopes (30-60%) with northern exposures (figs. 4, 24). The presence of *J. scopulorum* on these slopes has been attributed to increased snow catch and lower temperatures resulting from the northern aspect (Ralston 1960). This habitat type is most prevalent along the past and present drainageways of the Little Missouri River.

Most of the *J. scopulorum* stands have been logged in the past, and the frequency of *Fraxinus pennsylvanica* appears to increase with the intensity of harvest. The data from this and other studies (Nelson 1961, Ralston 1960, Hansen et al. 1984) indicate that *F. pennsylvanica* may have become an associated component of these stands; but *J. scopulorum* will retain dominance.

Table 11.—Vegetation data, by stratum, for the dominant species of the *Quercus macrocarpa/Corylus* species habitat type, in native woodlands of southwestern North Dakota.[1]

Species	Den /ha	Rel cover	Con
		(percent)	(percent)
TREE			
Fraxinus pennsylvanica	108	18	100
Quercus macrocarpa	517	77	100
Total 4 species	659	100	
SAPLING			
Amelanchier alnifolia	425	20	86
Prunus virginiana	517	18	86
Total 10 species	1993	100	
SHRUB			
Corylus spp.	7681	17	100
Prunus virginiana	31550	52	100
Total 12 species	88477	100	
HERBACEOUS			
Apocynum androsaemifolium		3.7	100
Aralia nudicaulis		4.2	67
Carex spp.		23	100
Galium boreale		4.5	100
Schizachne purpurascens		3.9	67
Symphoricarpos occidentalis		17	100
Total 42 species			

[1] *Rel = relative, Den = density, Con = constancy, ha = hectare*

Figure 23.—Interior of the *Quercus macrocarpa/Corylus* species habitat type.

Figure 24.—Exterior of the *Juniperus scopulorum/Oryzopsis micrantha* habitat type.

Soils.—The soils of the *Juniperus scopulorum/Oryzopsis micrantha* habitat type have developed on steep shale and scoria slopes. They classify as loam throughout most of the profile, with a slight increase in silt at 75 cm. The pH tended to increase slightly with depth; but these soils remain unleached. These soils have not been classified, but occupy landscapes that are often Entisols.

Vegetation.—In the *Juniperus scopulorum/Oryzopsis micrantha* habitat type, *J. scopulorum* was dominant in all three woody strata, illustrating its continued reproduction and capacity to dominate these habitat types (table 12, fig. 25). *J. scopulorum* was the only species encountered in the tree strata. It had a relative cover of 100% and a density of 975 trees/ha.

The density of *J. scopulorum* in the sapling layer was 1,458 saplings/ha and relative cover was 97%. *Fraxinus pennsylvanica* was present in this layer with a density of 33 saplings/ha, and relative cover of 3%. Total density was 1,491 saplings/ha.

J. scopulorum had the greatest density in the shrub layer, 1,509 stems/ha, and relative cover of 66%. *Potentilla fruticosa* provided 4% cover, and had a density of 3,018 stems/ha. Total shrub cover was very low (10%)—one of the lowest of all habitat types. The total density was 6,859 stems/ha and was greatest in open areas where there was a break in the dense *J. scopulorum* tree canopy. There were a total of eight species sampled in the shrub canopy. *J. scopulorum* was the only woody species with 100% constancy on all sites sampled.

A total of 51 species were recorded in the herbaceous layer. *Thuidium abietinum* and a few other minor moss species form the characteristic green mat which varies in thickness from a few centimeters to approximately 8 cm on most *J. scopulorum* slopes. It is important for soil stabilization and moisture retention, and can be easily disturbed and eroded. *T. abietinum* had relative cover of 29%, and *O. micrantha*, another characteristic species

of this layer, had a mean cover of 21%. *T. abietinum* was found exclusively in this habitat type. Other species contributing to the herbaceous canopy had much lower relative cover values. Other dominants with 100% constancy were *J. scopulorum*, 1.3% cover; *Campanula rotundifolia*, 0.3%; *Rhus aromatica*, 0.3%; and *Taraxacum officinale*, 0.5%. *J. communis* had 4% relative cover and *Galium boreale* had 2.4%, and both were present in 67% of the stands.

Other Studies.—Hansen et al. (1984) in Theodore Roosevelt National Park, North Dakota, and Hansen (1985) in northwestern South Dakota and southeastern Montana, described a *J. scopulorum/O. micrantha* habitat type. Ralston (1960) and Nelson (1961) described *J. scopulorum* communities in southwestern North Dakota.

Table 12.—Vegetation data, by stratum, for the dominant species of the *Juniperus scopulorum/Oryzopsis micrantha* habitat type, in native woodlands of southwestern North Dakota.[1]

Species	Den /ha	Rel cover	Con
		(percent)	(percent)
TREE			
Juniperus scopulorum	100	100	100
Total 1 species	100	100	
SAPLING			
Fraxinus pennsylvanica	2	3	33
Juniperus scopulorum	98	97	100
Total 2 species	100	100	
SHRUB			
Juniperus scopulorum	19	66	100
Prunus virginiana	10	4	100
Total 8 species	100	100	
HERBACEOUS			
Campanula rotundifolia		0.3	100
Juniperus scopulorum		1.3	100
Oryzopsis micrantha		21	100
Rhus aromatica		0.3	100
Taraxacum officinale		0.5	100
Thuidium abietinum		29	100
Total 51 species			

[1]*Rel = relative, Den = density, Con = constancy, ha = hectare*

Figure 25.—Interior of the *Juniperus scopulorum/Oryzopsis micrantha* habitat type.

Pinus ponderosa Series

Pinus ponderosa/Juniperus scopulorum Habitat Type

The largest population of *Pinus ponderosa* was found in Slope County, North Dakota covering approximately 9,880 ha. *P. ponderosa* has been documented at seven other locations in southwestern North Dakota; but these outliers cover very small areas (Potter and Green 1964a). These communities may be relicts of a previous, more widely distributed pine forest (Rudd 1951). More recent, intense research by Potter and Green (1964a) indicates that the Little Missouri River may have dispersed seeds, because most stands are near the river or its tributaries. Few populations exist on similar site conditions away from the river.

The topography is composed of gently rolling buttes, most with relatively moderate slopes which were nearly level to approximately 15%. The *P. ponderosa* stands occur in a parkland distribution with grassland stands scattered among them (fig. 26).

P. ponderosa can be found on slopes of all aspects. The north-facing slopes are more mesic and tend to support a more dense tree stand and ground cover of *Juniperus communis* and *J. horizontalis*. In contrast, south-facing slopes were more xeric, had a more open canopy, and a ground cover dominated by grass species. The species composition throughout the area was similar, but densities differed. There may be more habitat types based on different dominant understory associations resulting from different aspects and moisture conditions. But, because of the small area in question (9,880 ha), the high degree of similarity that does exist, and the fact that it would be impractical to differentiate between the different habitat types in a managment plan, only one habitat type has been described. Hansen (1985) described three *P. ponderosa* habitat types for southeastern Montana and northwestern South Dakota which are applicable to southwestern North Dakota.

Soils.—Most of the soils of the *Pinus ponderosa/Juniperus scopulorum* habitat type have developed in shale or sandstone deposits. Much of this material was

Figure 26.—Exterior of the *Pinus ponderosa/Juniperus scopulorum* habitat type.

subsequently baked by burning lignite veins into a bright red material locally known as "scoria," technically known as porcellanite. The fragmented, brick-like "scoria" favors the establishment of *P. ponderosa* because of its fast-growing tap root. The tap root follows fractures in the substrate to moisture, and the products of weathering also tend to accumulate here (Potter and Green 1964a).

In this habitat type, soil texture classified as loams and silt loams, with 11% or less clay. The pH readings increased with depth. These were among the highest pH measurements of all the woodland types. In other regions, *Pinus* spp. and other evergreens have tended to acidify the soil (Buol et al. 1980). Here the parent material was sodic (i.e., pH values of 8.4 to 8.8), this combined with low precipitation and high evapotranspiration rates have prevented leaching as evidenced by carbonates at the soil surface. The soils are typically Entisols.

Vegetation.—*Pinus ponderosa* stands were intermingled with grassland meadows and vegetation within the stands was relatively homogeneously distributed (table 13, fig. 27). Species diversity was one of the lowest of all habitat types. Two tree species provided total densities of 923 tree/ha. *P. ponderosa* had 92% mean cover; *Juniperus scopulorum* had 8%, with densities of 863 trees/ha and 69 trees/ha, respectively.

The same species were encountered in the sapling layer: *P. ponderosa* with 83% relative cover and 800 saplings/ha, and *J. scopulorum* with 16% cover and 75 saplings/ha. *Prunus virginiana* was also found in some stands; but its contribution to the canopy was not significant. Total density was 894 saplings/ha.

Table 13.—Vegetation data, by stratum, for the dominant species of the *Pinus ponderosa/Juniperus scopulorum* habitat type, in native woodlands of southwestern North Dakota.[1]

Species	Den /ha	Rel cover	Con
		(percent)	(percent)
TREE			
Juniperus scopulorum	69	8	75
Pinus ponderosa	863	92	100
Total 2 species	932	100	
SAPLING			
Juniperus scopulorum	75	16	75
Pinus ponderosa	800	83	100
Total 3 species	894	100	
SHRUB			
Pinus ponderosa	1646	31	75
Symphoricarpos occidentalis	14609	35	75
Total 6 species	21090	100	
HERBACEOUS			
Agropyron smithii		1.8	75
Bouteloua gracilis		3.7	75
Carex spp.		13.6	75
Melilotus officinalis		0.8	100
Pinus ponderosa		2.1	75
Symphoricarpos occidentalis		13	100
Total 60 species			

[1]*Rel = relative, Den = density, Con = constancy, ha = hectare*

Figure 27.—Interior of the *Pinus ponderosa/Juniperus scopulorum* habitat type.

A total of six species were present in the shrub canopy, and coverage in this layer was sparse compared to many other habitat types. The three dominant species included *Symphoricarpos occidentalis*, which had 34% relative cover and 14,609 stems/ha, *Pinus ponderosa* with 31% relative cover and 1,646 stems/ha and *Prunus virginiana* with 13% relative cover and 2,160 stems/ha. There was a total of 21,090 stems/ha.

In the herbaceous layer 60 species were sampled. Constancy rates for this habitat type were low which may be attributable to the fact that communities with different aspects have been combined. *S. occidentalis* and *Melilotus officinalis* were the only species with 100% constancy and had relative cover values of 13% and 0.8%, respectively. Species with 75% constancy and relatively high mean cover value were: *Carex* spp., 13.6%; *Bouteloua gracilis*, 3.7%; *Pinus ponderosa*, 2.1%; and *Agropyron smithii*, 1.8%. *J. horizontalis* and *J. communis* had high relative cover values, 16% and 7.2%, respectively, but only 50% constancy.

Other Studies.—Hansen (1985) described three *P. ponderosa* habitat types with *Agropyron spicatum*, *Prunus virginiana*, and *J. communis* in southeastern Montana and northwestern South Dakota. These habitat types have many characteristics similar to the *P. ponderosa/J. scopulorum* habitat type. Hoffman and Alexander (1987) described a *P. ponderosa-J. scopulorum* habitat type in the Black Hills of South Dakota. The associated species were similar, but site characteristics were very different.

Pinus flexilis Series

Pinus flexilis/Agropyron spicatum Habitat Type

The *Pinus flexilis/Agroypyron spicatum* habitat type is extremely limited within North Dakota. Only approximately 495 ha are covered by this habitat type, which is north of Marmath, North Dakota (fig. 28). The establishment of *P. flexilis* here has been discussed in the previous section. Slopes of this habitat type were approximately 30%.

Figure 28.—Exterior of the *Pinus flexilis/Agropyron spicatum* habitat type.

P. flexilis is shade intolerant and is considered seral in most communities, except when associated with *Populus tremuloides*, *Juniperus scopulorum* and *Pinus ponderosa* (Steele, in press). In the study area, trees are widely spaced providing very little shade, and the only associated tree species is *Juniperus scopulorum* which it is reported to outcompete. Therefore, it can be concluded that *Pinus flexilis* is maintaining itself in these communities. The presence of *P. flexilis* in southwestern North Dakota has been attributed to seeds which were transported by native Americans who used them as a food source (Potter and Green 1964b, Beckes et al. 1982).

Soils.—Soil samples were not collected because of the stoniness of the substrate. These soils are somewhat similar to those of the *Pinus ponderosa/Juniperus scopulorum* habitat type. Soils in the *Pinus flexilis/Agropyron spicatum* habitat type appear to be less developed which may be the result of steeper slopes and the relative youthfulness of this population.

Vegetation.—Diversity, density, and mean cover of the *Pinus flexilis/Agropyron spicatum* association was the lowest of all types sampled (table 14, fig. 29). Two species, *P. flexilis* with 90% relative cover and 400 trees/ha and *Juniperus scopulorum* with 10% relative cover and 63 trees/ha, composed the tree canopy. Total mean cover in this layer was only 44%, the lowest of all habitat types. Density was 463 trees/ha which illustrates the open nature of the canopy and wide spacing between individuals.

The same two species were the only ones encountered in the sapling layer, having a total cover and density of 29% and 1,088 saplings/ha. Relative cover and density was 83% and 788 saplings/ha for *P. flexilis* and 17% with 300 saplings/ha for *J. scopulorum*.

Four species were recorded in the shrub layer. *P. flexilis* had a relative cover of 41% and a density of 1,029 stems/ha; *Rhus aromatica* had 23% cover and 1,646 stems/ha. *Symphoricarpos occidentalis* and *Juniperus scopulorum* also contributed to the total shrub cover which was 9%, the lowest of all encountered. Total density was 4,527 stems/ha.

Table 14.—Vegetation data, by stratum, for the dominant species of the *Pinus flexilis/Agropyron spicatum* habitat type, in native woodlands of southwestern North Dakota.[1]

Species	Den /ha	Rel cover	Con
		(percent)	(percent)
TREE			
Juniperus scopulorum	63	10	100
Pinus flexilis	400	90	100
Total 2 species	463	100	
SAPLING			
Juniperus scopulorum	300	17	100
Pinus flexilis	788	83	100
Total 2 species	1088	100	
SHRUB			
Pinus flexilis	1029	41	50
Rhus aromatica	1646	23	100
Total 4 species	4527	100	
HERBACEOUS			
Agropyron spicatum		5.4	100
Calamovilfa longifolia		6	100
Carex spp.		8.3	100
Juniperus horizontalis		26	100
Juniperus scopulorum		7.7	100
Melilotus officinalis		17	100
Total 36 species			

[1] *Rel = relative, Den = density, Con = constancy, ha = hectare*

Figure 29.—Interior of the *Pinus flexilis/Agropyron spicatum* habitat type.

There were 36 species recorded in the herbaceous layer of this habitat type. Dominant species and their mean cover values were: *J. horizontalis*, 26%; *Melilotus officinalis*, 17%; *Carex* spp., 8.3%; *J. scopulorum*, 7.7%; *Calamovilfa longifolia*, 6%; and *A. spicatum*, 5.4%. These species all had 100% constancy. *A. spicatum* has a limited distribution in the study area. It was encountered only in *Pinus* woodlands, and thus it helps characterize this habitat type.

Other Studies.—Whitman (1979) described a *P. flexilis/A. spicatum* plant community for southwestern North Dakota. Potter and Green (1964b) and Beckes et al. (1982) have discussed the ecology and composition of the *P. flexilis* communities of southwestern North Dakota.

Other Vegetation Types

The distribution of certain vegetation types was limited to only one or a few stands in the study areas. These stands were sampled and described to make a more complete classification. It is difficult to determine the ecological status of a community based on one sample. Therefore, these single stand types have been included in this section, and their theoretical potential has been determined based on limited data.

Populus tremuloides/Betula papyrifera Community Type

Distribution and Environment.—An isolated stand of *Populus tremuloides* and *Betula papyrifera* was encountered in McKenzie County in an exclosure erected in the 1960's (fig. 30). The site is extremely mesic, on a north-facing slope near a spring. The substrate tends to be erosional because of the moisture and steep slope (50%). The sample site may have been disturbed prior to its exclusion, because it was thought to be a sucessional stage of the *P. tremuloides/Prunus virginiana* habitat type. Although *B. papyrifera* is the canopy cover dominant of the tree stratum, *Populus tremuloides* density in all woody layers was greater, and thus it is likely to eventually dominate. *B. papyrifera* may survive as an associated or understory species. There are somewhat similar successional stands in the Killdeer Mountains; but the presence of *Corylus* species and different site characteristics results in a different community type.

Soils.—The soil texture of the *Populus tremuloides/Betula papyrifera* community type was sandy loam. The surface 0–15 cm was loam, which graded into a sandy loam at 15–30 cm and a sandy clay loam at 30–75 cm. The 75–90 cm increment was again a sandy loam. The pH varied from 6.9 to 7.2, but no consistent changes with depth occurred.

Vegetation.—The *Populus tremuloides/Betula papyrifera* community type was dominated by both species in the tree canopy (table 15, fig. 31). *B. papyrifera* had relative cover of 75%, much greater than *P. tremuloides* at 25%. *B. papyrifera* has a more branching and spreading growth form. However, *P. tremuloides* had a slightly higher density of 300 trees/ha compared with 275 trees/ha for *B. papyrifera*. No other species were sampled in the tree strata, and total density was 575 trees/ha.

In the sapling layer, the relative cover was equal for the dominant species of *P. tremuloides* and *B. papyrifera*, 38%. *P. tremuloides* had a much greater density of 1,025 saplings/ha than *B. papyrifera* with 200/ha. Total density was 2,325 saplings/ha, which was relatively high. *Amelanchier alnifolia* and *Prunus virginiana* were present and had less than 10% mean cover.

Cornus stolonifera dominated the shrub canopy at 37% relative cover with 16,872 stems/ha. *Populus tremuloides*

Table 15.—Vegetation data, by stratum, for the dominant species of the *Populus tremuloides/Betula papyrifera* community type, in native woodlands of southwestern North Dakota.[1]

Species	Den /ha	Rel cover	Con
		(percent)	(percent)
TREE			
Betula papyrifera	275	75	100
Populus tremuloides	300	25	100
Total 2 species	575	100	
SAPLING			
Betula papyrifera	200	38	100
Populus tremuloides	1025	38	100
Total 6 species	2325	100	
SHRUB			
Cornus stolonifera	16872	37	100
Populus tremuloides	4115	17	100
Total 11 species	72429	100	
HERBACEOUS			
Aralia nudicaulis		11	100
Carex spp.		7.7	100
Cornus stolonifera		13	100
Prunus virginiana		7.1	100
Symphoricarpos occidentalis		9.5	100
Toxicodenderon rydbergii		8.4	100
Total 32 species			

[1] *Rel = relative, Den = density, Con = constancy, ha = hectare*

Figure 30.—Exterior of the *Populus tremuloides/Betula papyrifera* community type.

Figure 31.—Interior of the *Populus tremuloides/Betula papyrifera* community type.

had the next greatest relative cover at 17% and 4,115 stems/ha. *F. pennsylvanica*, *A. alnifolia* and Prunus virginiana were also associates in this layer. Total density was 72,429 stems/ha.

No *B. papyrifera* was encountered in the shrub layer, and only 0.4% of the herbaceous cover was attributed to it. The greater density of *Populus tremuloides* indicates its potential to dominate in the future.

In this community type, there were 32 species in the herbaceous canopy. The dominant species had 100% constancy and the following mean cover values: *C. stolonifera*, 13%; *Aralia nudicaulis*, 11%; *Symphoricarpos occidentalis*, 9.5%; *Carex* spp., 7.7%; *Toxicodenderon rydbergii*, 8.4%; and *Prunus virginiana*, 7.1%.

Populus tremuloides/Quercus macrocarpa Community Type

Distribution and Environment.—One stand of the *Populus tremuloides/Quercus macrocarpa* community type was sampled; its distribution is extremely limited. It occurred at the head of a well-defined intermittent drainageway in uplands of northeastern McKenzie County. Headward erosion is occurring causing the substrate to be unstable. The slope was approximately 25%.

P. tremuloides is sometimes considered to be a seral species. It appears that this community type is in transition to a *Quercus macrocarpa/Prunus virginiana* habitat type. There is an abundance of *Q. macrocarpa*, with some *Fraxinus pennsylvanica* in the upper and lower, more stable topographic positions, and inside the shrubby border (fig. 32). The *P. tremuloides* may have colonized the area and increased the stability of the slopes; it is being replaced by *Q. macrocarpa* in the natural scheme of succession. *P. tremuloides* is successfully reproducing in the understory along with *Q. macrocarpa*; but many of the older *P. tremuloides* trees are dying. The vigor of *Q. macrocarpa* and apparent expansion from the borders and lower draw positions into the more recently stabilized interior of the woodland have lead to the conclusion that this community type is seral.

Soils.—Soils of the *Populus tremuloides/Quercus macrocarpa* community type ranged from loams to silt loams. At depths of 0–30 cm and 60–75 cm, the texture was loam. Slightly higher silt and lower sand content caused the deeper increments to classify as silt loam. The wide range of soil textures is attributed to the erosiveness of the substrate at this site. The pH increased with depth to a high of 8.7 which was the most basic pH recorded in all woodland soil samples. These soils are relatively new and unleached.

Vegetation.—Four tree species were sampled in the *Populus tremuloides/Quercus macrocarpa* community type (table 16, fig. 33) which had a total density of

Table 16.—Vegetation data, by stratum, for the dominant species of the *Populus tremuloides/Quercus macrocarpa* community type, in native woodlands of southwestern North Dakota.[1]

Species	Den /ha	Rel cover	Con
		(percent)	(percent)
TREE			
Populus tremuloides	900	66	100
Quercus macrocarpa	150	25	100
Total 4 species	1125	100	
SAPLING			
Populus tremuloides	875	65	100
Quercus macrocarpa	75	21	100
Total 5 species	1325	100	
SHRUB			
Populus tremuloides	12757	32	100
Symphoricarpos occidentalis	48148	30	100
Total 10 species	92182	100	
HERBACEOUS			
Disporum trachycarpum		4.8	100
Lathyrus ochroleucus		8.3	100
Prunus virginiana		5.4	100
Sanicula marylandica		10	100
Symphoricarpos occidentalis		17	100
Viola canadensis		6.5	100
Total 45 species			

[1]*Rel = relative, Den = density, Con = constancy, ha = hectare*

Figure 32.—Exterior of the *Populus tremuloides/Quercus macrocarpa* community type.

Figure 33.—Interior of the *Populus tremuloides/Quercus macrocarpa* community type.

1,125 trees/ha. *P. tremuloides* had 66% relative cover at 900 trees/ha; and *Q. macrocarpa* with 25% cover and 150 trees/ha. *Fraxinus pennsylvanica* and *Acer negundo* were present but had less than 5% relative cover and densities of 50 trees/ha or less.

Five sapling species were sampled and found to have a total of 1,325 saplings/ha. *P. tremuloides* was again the dominant at 65% relative cover and 875 saplings/ha; followed by *Q. macrocarpa* with 21% cover and 75 saplings/ha.

In the shrub canopy there were 10 species, with 92,182 stems/ha. *P. tremuloides* dominated this canopy at 32% relative cover and 12,757 stems/ha; with *Symphoricarpos occidentalis* at 26% and 48,148 stems/ha; and *Prunus virginiana* at 7% and 9,877 stems/ha.

The herbaceous layer had 45 species. The dominant species and their relative cover values were: *S. occidentalis*, 17%; *Sanicula marylandica*, 10%; *Lathyrus ochroleucus*, 8.3%; *Viola canadensis*, 6.5%; *P. virginiana*, 5.4%; and *Disporum trachycarpum*, 4.8%. Total graminoid cover was 8%.

Betula papyrifera/Corylus cornuta Community Type

Distribution and Environment.—The *B. papyrifera/Corylus cornuta* community type (fig. 34) also is in the Killdeer Mountains, and appears to be disturbed and succeeding toward a *Quercus macrocarpa/C.* species habitat type. *B. papyrifera* usually is a seral species in the tree canopy. The absence of *B. papyrifera* in the understory and presence of *Q. macrocarpa* in all woody canopies indicates this trend. This community type is fairly abundant in the Killdeers; but only 1 stand was sampled. Site characteristics are similar to those of the *Q. macrocarpa/Corylus* species habitat type. The slope of this stand was nearly level.

Soils.—Soil texture of the *Betula papyrifera/Corylus cornuta* community type was silt loam at the surface, 0–15cm. All other depths classified as loam. The pH increased from 6.8 to 8.4 to a depth of 75 cm. These soils appear to be leached to 45 cm, with an Argillic horizon at 15–60 cm.

Figure 34.—Exterior of the *Betula papyrifera/Corylus cornuta* community type.

Vegetation.—The *Betula papyrifera/Corylus cornulata* community type contained 4 tree species (table 17, fig. 35). *B. papyrifera* had 58% relative cover, *Quercus macrocarpa* 23% and *Populus tremuloides* 12%. All had densities of 175 trees/ha. *Fraxinus pennsylvanica* was present with 7% relative cover, and 100 trees/ha. Total density was 625 trees/ha.

F. pennsylvanica dominated the saplings with 32% relative cover and 425 saplings/ha, followed by *C. cornuta* with 28% and 2,200 stems/ha. *Q. macrocarpa* and *Amelanchier alnifolia* both had 9% cover and densities of 200 and 850 saplings/ha, respectively. Although *F. pennsylvanica* dominated the saplings, it may eventually be outcompeted by *Q. macrocarpa*. *F. pennsylvanica*

Table 17.—Vegetation data, by stratum, for the dominant species of the *Betula papyrifera/Corylus cornuta* community type, in native woodlands of southwestern North Dakota.[1]

Species	Den /ha	Rel cover	Con
		(percent)	(percent)
TREE			
Betula papyrifera	175	58	100
Quercus macrocarpa	175	23	100
Total 4 species	625	100	
SAPLING			
Corylus cornuta	2200	28	100
Fraxinus pennsylvanica	425	32	100
Total 7 species	2250	100	
SHRUB			
Corylus cornuta	14403	31	100
Prunus virginiana	20576	29	100
Total 9 species	79424	100	
HERBACEOUS			
Apocynum androsaemifolium		7.4	100
Aralia nudicaulis		8.9	100
Carex spp.		11	100
Prunus virginiana		6.5	100
Schizachne purpurascens		27	100
Symphoricarpos occidentalis		9.1	100
Total 37 species			

[1] *Rel = relative, Den = density, Con = constancy, ha = hectare*

Figure 35.—Interior of the *Betula papyrifera/Corylus cornuta* community type.

is not a dominant tree canopy in these sites, and *Q. macrocarpa* is dominant in the lower layers. Seven sapling species were sampled whose total cover equalled 81% and total density was 2,550 saplings/ha.

Many of the same species dominated the sapling and shrub canopies. *Cornus cornuta* had 23% mean cover and 14,403 stems/ha; *Prunus virginiana* with 21% and 20,576 stems/ha; and *Q. macrocarpa* with 11% and 1,235 stems/ha. There was a total of nine species, which had 74% total cover and 79,424 stems/ha.

A total of 37 species was encountered in the herbaceous layer. Mean cover values and the dominant species are: *Schizachne purpurascens*, 44%; *Carex* spp., 18%; *Aralia nudcaulis*, 15%; *Apocynum androsaemifolium*, 12%; and *P. virginiana*, 11%. Only one stand of this community type was sampled; therefore, all species have 100% constancy. This was one of the few woodland types where graminoid species were dominant in the herbaceous canopy.

Betula papyrifera/Clematis occidentalis Habitat Type

Distribution and Environment.—The *Betula papyrifera/Clematis occidentalis* habitat type occurred only in the Killdeer Mountains (fig. 5). The unique topography, geology, and climate of this habitat type were described in the *Quercus macrocarpa/Corylus* species habitat type which was a more widely distributed type.

This habitat type was restricted in its distribution to near the top of steep (30%), north-facing slopes, and did not appear to have been cut over in the past (fig. 36). Only one stand of this habitat type was sampled; but it was observed in the same topographic position in a few other areas of the Killdeers. The presence of this habitat type may be the result of cold soil conditions which favor the success of *B. papyrifera* over *P. tremuloides* (Safford et al., in Press). *P. tremuloides* increased downslope from this habitat type.

Soils.—Soil texture of the *Betula papyrifera/Clematis occidentalis* habitat type was sandy or silty loam throughout most of the profile with less than 8% clay. The pH showed a range from 7.6 at the surface, to 8.0 at 90 cm. The texture and pH indicated that these soils are unleached Orthents.

Vegetation.—*B. papyrifera* was the only species present in the tree stratum of the *Betula papyrifera/Clematis occidentalis* habitat type, and, therefore, had 100% relative cover. It had a density of 475 trees/ha (table 18, fig. 37).

B. papyrifera was dominant in the sapling strata, contributing 700 of the 725 saplings/ha and all of the 100% relative cover. *Corylus cornuta* had 25 saplings/ha, but contributed less than 1% to the relative cover.

There were eight species in the shrub canopy. *C. cornuta* dominated the canopy having 63% relative cover with 29,630 stems/ha. The second most frequent species

Table 18.—Vegetation data, by stratum, for the dominant species of the *Betula papyrifera/Clematis occidentalis* habitat type, in native woodlands of southwestern North Dakota.[1]

Species	Den /ha	Rel cover	Con
		(percent)	(percent)
TREE			
Betula papyrifera	475	100	100
Total 1 species	625	100	
SAPLING			
Betula papyrifera	700	100	100
Corylus cornuta	25	0	100
Total 2 species	725	100	
SHRUB			
Corylus cornuta	29630	63	100
Prunus virginiana	32099	24	100
Total 9 species	91770	100	
HERBACEOUS			
Clematis occidentalis		5.2	100
Corylus cornuta		8.7	100
Galium boreale		5.4	100
Prunus virginiana		9.4	100
Rosa woodsii		10	100
Symphoricarpos occidentalis		13	100
Total 30 species			

[1]*Rel = relative, Den = density, Con = constancy, ha = hectare*

Figure 36.—Exterior of the *Betula papyrifera/Clematis occidentalis* habitat type.

Figure 37.—Interior of the *Betula papyrifera/Clematis occidentalis* habitat type.

was *Prunus virginiana* with 24% relative cover and 32,099 stems/ha. All other species had less than 4% relative cover. There was a total of 91,770 stems/ha which had total cover of 75%.

This plant association had 30 species in the herbaceous strata. *Symphoricarpos occidentalis* had 13% relative cover; *Rosa woodsii*, 10%; *Prunus virginiana*, 9.4%; *C. cornuta*, 8.7%; *Galium boreale*, 5.4%; and *Clematis occidentalis*, 5.2%. *C. occidentalis* was a characteristic forb of this habitat type but considered a rare plant in North Dakota. *C. occidentalis* appears to be limited exclusively to this habitat type and immediately adjacent areas. Graminoid species were not prevalent in this habitat type.

SUMMARY

Seven series were recognized for the woodland habitat type classification of southwestern North Dakota. Within these series, there were nine habitat types, one phase, and five community types. These woodland types have a number of similarities and dissimilarities and an endless number of comparisons which can be made.

Review of Woodland Habitat and Community Types

***Fraxinus pennsylvanica* Series.**—The *Fraxinus pennsylvanica* series contained three habitat types and two community types. The *F. pennsylvanica/Prunus virginiana* habitat type formed long stringers in uplands following intermittent drainageways. A shrubby border characterized the woodland/grassland border. The *F. pennsylvanica/P. virginiana* habitat type *Ulmus americana* phase occurred along intermittent streams and drainageways of the uplands, floodplains of major streams, and on north-facing slopes. This habitat type was similar in most respects to the *F. pennsylvanica/P. virginiana* habitat type and was distinguished primarily by the presence of *U. americana* and the variety of topographic positions. The *F. pennsylvanica/Symphoricarpos occidentalis* habitat type was restricted to the floodplains of the Little Missouri River. The presence of *P. virginiana* was very limited, and *S. occidentalis* is the understory dominant (table 19). The *Populus deltoides/F. pennsylvanica* and *P. deltoides/Juniperus scopulorum* community types were seral communities of the *F. pennsylvanica/S. occidentalis* habitat type. The *P. deltoides/J. scopulorum* was the earlier seral stage with *J. scopulorum* dominating the understory and *F. pennsylvanica* was a minor component. The *P. deltoides/F. pennsylvanica* was the later seral stage. *F. pennsylvanica* was dominant in the understory, and will eventually dominate the overstory.

***Populus tremuloides* Series.**—There was one habitat type and one community type in the *Populus tremuloides* series. The *P. tremuloides/ Prunus virginiana* habitat type was most common on the shoulder and backslope topographic positions, with grasslands dominant on the summit and shoulder positions, and the *F. pennsylvanica/P. virginiana* habitat type *U. americana* phase dominant downslope. The *Populus tremuloides/Betula papyrifera* community type was on an extremely mesic site. *B. papyrifera* had more total cover; but *P. tremuloides* had greater density, indicating that *P. tremuloides* will eventually dominate this type.

***Quercus macrocarpa* Series.**—The *Quercus macrocarpa* series contained two habitat types and two community types. The *Q. macrocarpa/ Prunus virginiana* habitat type formed relatively extensive communities on backslopes of intermittent streams and drainageways. This habitat type was limited to glaciated areas. The *Populus tremuloides/Q. macrocarpa* community type occupied erosive slopes. Once these areas become stabilized, the *Q. macrocarpa/Prunus virginiana* habitat type probably will result because *Q. macrocarpa* was reproducing in the understory. The *Q. macrocarpa/Corylus* species habitat type was found in the Killdeer Mountains and adjacent areas. This habitat type was on gentle slopes and the soils were more leached than many of the other types. The *B. papyrifera/Corylus cornuta* community type occupied similar sites and appears to be seral to the *Q. macrocarpa/Corylus* species habitat type.

***Betula papyrifera* Series.**—*B. papyrifera/Clematis occidentalis* was the only habitat type in the *B. papyrifera* series. This habitat type was only in the Killdeer Mountains, near the top of steep, north-facing slopes. *C. occidentalis* is considered to be a rare species in North Dakota; its distribution appeared to be limited to this habitat type and adjacent areas.

***Juniperus scopulorum* Series.**—The *J. scopulorm* series contained one habitat type, *J. scopulorum/Oryzopsis micrantha*. This habitat type was limited to steep, north-facing slopes. *Thuidium abietinum* a species of moss, and *O. micrantha* formed a distinct, characteristic herbaceous stratum.

***Pinus ponderosa* Series.**—Pinus ponderosa distribution in southwestern North Dakota was primarily limited to a small area in Slope County. The *P. ponderosa/J. scopulorum* habitat type was found on all aspects of "scoria" buttes in this area. The total cover and species diversity of this habitat type was relatively low.

***Pinus flexilis* Series.**—*P. flexilis* was limited in its distribution to a small area in Slope County, North Dakota. The *P. flexilis/Agropyron spicatum* habitat type was recognized, and it was found on all aspects of "scoria" buttes. *A. spicatum* was not widely distributed in southwestern North Dakota; it was primarily limited to the pine areas.

Table 19.—The arrangement of *Fraxinus pennsylvanica* woodland sites from TWINSPAN classification based on presence or absence and total cover values of species sampled in the shrub (B) and sapling (S) layers. Values for total cover classes are: 1 = 0-2%, 2 = 2-5%, 3 = 5-10%, 4 = 10-20%, 5 = 20-50%, 6 = 50-100%.[1]

Species	Site Number																			
	2	3	8	2	1	3	3	3	4	4	3	1	2	3	4	2	4	1	2	
	7	3			1	1	2	5	2		0	7	9	4	3	6	1	3	1	
Crataegus rotundifolia S	1		3																	
Cornus stolonifera B	3													1		3	1			
Cornus stolonifera S	2															4	2			
Amelanchier alnifolia B	3	4				1							1	1						
Amelanchier alnifolia S	3	2	2	2		3		1												
Ribes americana B	5							1												
Salix spp. S	2											2								
Viburnum lentago S	5																			
Prunus pennsylvanica B			1																	
Salix spp. B												1								
Acer negundo S		1									1	2					1			
Acer negundo B		1															3			
Ulmus americana B			1														5			
Prunus virginiana S	4	1	4	5	5	4	6	4	1	1	1		1							
Ulmus americana S	4	3	2			5	2	2									5			
Prunus americana S	1		3	4	2			1	2											
Prunus americana B																				
Rhus trilobata S			1							2		2	3							
Ribes odoratum B			2		1					1										
Rosa woodsii S							1	1								1	1			
Prunus virginiana B	5	4	4	5	6	6	6	6	5	3	2		1		1		1			
Fraxinus pennsylvanica S	4	2	3	6	5	6	4	2	5	3	1	5	3	6	6	6	1	1		
Rosa woodsii B	2	1	5	1	1		4	3		1	1	5	4	5	5	5	3	2	1	
Ribes missouriensis B	2	1			1	1			2	1			2		2			1	1	
Fraxinus pennsylvanica B		3	1	1	2	3			2	3	1	3	2	5	2	4	4	5	2	
Symphoricarpos occidentalis B	1	1	1	4	5	1	2	6	4	5	6	5	6	5	5	4	2	3	2	
Juniperus scopulorum S									1		3	2	3	3		5	4	5		
Rhus trilobata B									1		1						1	4		
Juniperus scopulorum B							1		1		2			1		3	2			

Comparison of Similar Habitat and Community Types Based on Similar Topography

Topography plays a very important role in the distribution of woodland habitat types. The TWINSPAN classification and DECORANA ordination illustrated the similarities of sites of the same series and habitat type, and also the similarity of sites on the same topographies. Five topographic divisions were made: (1) uplands, (2) floodplains, (3) north-facing slopes, (4) Killdeer Mountains, and (5) "scoria" buttes.

Uplands.—The upland hardwood habitat types were located in draws as isolated pockets and stringers, on north-facing slopes, following intermittent streams and drainageways (fig. 2). The establishment and survival of the upland hardwood types was closely linked to areas of increased moisture. There were four upland hardwood habitat types recognized for southwestern North Dakota. The habitat types were: *Fraxinus pennsylvanica/Prunus virginiana*, *F. pennsylvanica/P. virginiana Ulmus americana* phase, *Populus tremuloides/Prunus virginiana*, and *Quercus macrocarpa/P. virginiana*. All types had a shrubby border at the grassland/woodland interface. All types had *P. virginiana* as an understory dominant, regardless of the dominant tree species. These types also had several other species in common: *Amelanchier alnifolia*, *Carex* spp. (primarily *C. sprengelii*), *F. pennsylvanica*, *Galium boreale*, and *Symphoricarpos occidentalis* were the most predominant.

Floodplains.—The floodplains of the Little Missouri River support gallery forests (fig. 3). As the river meanders, eroding one bank while depositing on the other bank, it forms an environment free from competition and favorable to the establishment of *Populus deltoides*. There was one habitat and two community types recognized on the floodplains: *P. deltoides/Juniperus scopulorum* and *P. deltoides/F. pennsylvanica* community types which were seral to the *F. pennsylvanica/Symphoricarpos occidentalis* habitat type. The *P. deltoides/J. scopulorum* community type was found nearest the river on the more recent alluvial deposits. This gradually graded into the more mature *P. deltoides/F. pennsylvanica* community type as the amount of *J. scopulorum* decreased and *F. pennsylvanica* increased. The *F. pennsylvanica/S. occidentalis* habitat type occupied the oldest alluvial deposits and represented the potential natural community. Species common to all three types were: *Elymus canadensis*, *F. pennsylvanica*,

Melilotus officinalis, Rosa woodsii, S. occidentalis, Thalictrum species and *Toxicodenderon rydbergii.*

Killdeer Mountains.—The Killdeer Mountains form a "unique island" whose elevation, topography, microclimate, soils, and vegetation were distinctly different from those of the surrounding plains (fig. 5). Many of the characteristics of the Killdeer Mountains bore a greater similarity to eastern deciduous forests than to other plains woodlands. There were two habitat types and one community type recognized in the Killdeer Mountains: the *Q. macrocarpa/Corylus* species and *Betula papyrifera/Clematis occidentalis* habitat types, and the *B. papyrifera/Corylus cornuta* community type. All types had *Corylus* species present in the understory; these species were not present in any other types. Other common species were *A. alnifolia, G. boreale, Prunus virginiana* and *S. occidentalis.*

North Slopes.—The steep, north-facing slopes were most common along past and present drainageways of the Little Missouri River and its major tributaries (fig. 4). These slopes were very steep and soils were shallow. The *J. scopulorum/Oryzopsis micrantha* habitat type dominates these sites. Species commmonly found on these slopes were: *J. scopulorum, O. micrantha, Rhus aromatica,* and *Thuidium abietinum.*

"Scoria" Buttes.—The "scoria" (baked clay) buttes have limited soil development (fig. 6). The platelike layers of "scoria"' favored the tap root systems of woody species, especially conifers. *Pinus ponderosa/J. scopulorum* and *P. flexilis/Agropyron spicatum* habitat types were primarily restricted to "scoria" buttes in Slope County, North Dakota. These two habitat types had several species common to both: *Agropyron smithii, A. spicatum, J. communis, J. horizontalis, J. scopulorum, M. officinalis,* and *Rhus aromatica.*

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Appendix A.

Relative cover values for woody species of the *Fraxinus pennsylvanica/Prunus virginiana* habitat type in southwestern North Dakota. (T = tree, S = sapling, B = shrub).

		Fraxinus pennsylvanica/ Prunus virginiana ht			*Fraxinus pennsylvanica/Prunus virginiana* ht *Ulmus americana* phase						
Site		2	11	42	8	27	31	32	33	35	41
Sec.		SENE21	NENE6	SENW24	SESW7	SWNW24	SWSW2	NENE19	NESW10	NENW17	NENW36
Town.		139N	104N	136N	146N	147N	17N	144N	143N	153N	149N
Range		102W	102W	103W	99W	99W	59E	103W	105W	96W	97W
Acer negundo	T		26						12	7	30
	S								8		1
	B								2		11
Fraxinus pennsylvanica	T	100	100	74	81	28	78	63	47	73	54
	S	46	46	85	18	14	52	25	28	14	5
	B	2	3	5	0		10		15		14
Juniperus scopulorum	T				1			1			
	S										
	B							0			
Ulmus americana	T				17	72	22	37	41	20	12
	S				4	16	30	4	41	10	84
	B				2		4				60
Amelanchier alnifolia	S	4			7	9	5		19	2	
	B				4	7	2		39		
Cornus stolonifera	S					4			2		8
	B					6					1
Crataegus rotundifolia	S				18	2					
	B										
Prunus americana	S	13	3	13	19	1				6	
	B	2	0		22		1				
Prunus pennsylvanica	S				0						
	B										
Prunus virginiana	S	37	51	2	30	20	14	70	5	58	
	B	63	68	64	24	45	85	89	38	45	
Rhus aromatica	S				3						
	B										
Ribes species	B		1	5	4	37	3		2	0	
Rosa woodsii	S									11	2
	B	3	1		41	3		8	1	4	11
Salix species	T										4
	B					4					
Symphoricarpos occidentalis	B	30	27	26	3	2	0	3	1	50	4
Viburnum lentago	S										
	B					30					

Appendix B.

Relative cover values for woody species of the *Fraxinus pennsylvanica/Symphoricarpos occidentalis* habitat type in southwestern North Dakota. (T = tree, S = sapling, B = shrub).

		Fraxinus pennsylvanica/ Symphoricarpos occidentalis ht			*Populus deltoides/ F. pennsylvanica* ct		*P. deltoides/ Juniperus scopulorum* ct			
Site		26	30	43	17	34	4	13	21	29
Sec.		SENW4	NENE11	SESE32	NENE36	SESE32	NESW27	NESE1	SESE16	SENW31
Town.		147N	140N	144N	147N	144N	140N	140N	140N	140N
Range		99W	102W	102W	100W	102W	102W	102W	102W	99W
Acer	T									
negundo	S		26		5					
Fraxinus	T	100	100	96	13	19	3	2		1
pennsylvanica	S	90	52	93	76	92	56	2		29
	B	30	1	7	12	26	14	59	10	5
Juniperus	T			4		13	23	27	30	12
scopulorum	S			7	9	8	10	98	100	22
	B			3	5		3	9		
Populus										
deltoides	T				87	68	74	71	70	87
Cornus	S	10								
stolonifera	B	9				1				
Prunus	S		22				10			1
virginiana	B		2	1			13			1
Rhus	S				8		24	1	51	49
aromatica	B				0		0			
Ribes										
spp.	B			7			1	1	5	3
Rosa	S	0								
woodsii	B	38	1	37	38	36	1	12	0	19
Salix	S				3					
spp.	B				0					
Symphoricarpos										
occidentalis	B	23	95	46	45	37	67	18	34	70

Appendix C.

Relative cover values for woody species of the *Populus tremuloides/Prunus virginiana* habitat type in southwestern North Dakota. (T = tree, S = sapling, B = shrub).

		Populus tremuloides/ Prunus virginiana ht							*P. tremuloides/ Betula papyrifera* ct
Site		**7**	**10**	**16**	**25**	**28**	**36**	**39**	**19**
Sec.		**SWSW8**	**SWSW9**	**NWNW11**	**NWNW24**	**SESE9**	**NESE10**	**SENE15**	**NESW18**
Town.		**146N**	**139N**	**147N**	**147N**	**147N**	**153N**	**151N**	**147N**
Range		**99W**	**103W**	**100W**	**99W**	**101W**	**95W**	**95W**	**98W**
Betula papyrifera	T								75
	S								38
Fraxinus pennsylvanica	T	16	11	7	5	17	28	7	
	S	2	51	23	39	80	18		
	B	24	5	4	0	11	1	4	
Juniperus scopulorum	T					33			
	S					2			
	B					2			6
Populus tremuloides	T	81	89	93	93	50	64	63	25
	S	69	23	59	19	10	5	76	38
	B	1	8	7	2		9	31	
Quercus macrocarpa	T							16	
Ulmus americana	T	3			2		8	14	
	S				6				
	B					1	0		
Amelanchier alnifolia	S	2	20	13	18	7	10	5	10
	B	10	6	17	49		12	4	
Corylus species	S								
	B			1					
Cornus stolonifera	S	11	4		13	3	66		3
	B		16		38	0	6		
Crataegus rotundifolia	S								
	B				1				
Prunus americana	S	5		1					
	B	7							
Prunus pennsylvanica	S	11					1		
	B	1							
Prunus virginiana	S		0	4	0	6	17	1	6
	B	4	54	66	5	61	43	1	
Rhus aromatica	S								
	B		0			8	1		
Ribes species	B	5	0	0	2	3	1		
Rosa woodsii	S								
	B	5		2	3	4	7	40	
Salix spp.	S	10	2		4				5
	B		2						
Symphoricarpos occidentalis	B	33	10	4	2	4	21	20	

Appendix D.

Relative cover values for woody species of the *Quercus macrocarpa* and *Betula papyrifera* habitat types in southwestern North Dakota. (T = tree, S = sapling, B = shrub).

		Quercus macrocarpa/ Prunus virginiana ht		*Populus tremuloides/* Q. macrocarpa ct	Q. *macrocarpa/ Cornus* species ht			*Betula papyrifera/ Cornus cornuta* ct	*B. papyrifera/ Clematis occidentalis* ht
Site		**37**	**40**	**38**	**5**	**20**	**23**	**6**	**22**
Sec.		**SENE21**	**NENE6**	**SENW24**	**SENW21**	**SESW35**	**SENE27**	**SWNE21**	**NESE17**
Town.		**153N**	**151N**	**153N**	**146N**	**147N**	**146N**	**146N**	**153N**
Range		**95W**	**95W**	**96W**	**96W**	**97W**	**96W**	**96W**	**96W**
Acer negundo	S			5					
Betula papyrifera	T							58	100
	S				26				100
Fraxinus pennsylvanica	T	32	13	4	20	10	23	7	
	S	31	23				28	32	
	B	13	16	3	0		4	3	
Populus tremuloides	T	3		66	2			12	
	S	3		65	16			10	
	B	3		32	1				
Quercus macrocarpa	T	65	87	25	63	90	77	23	
	S	66	33	21	10		14	11	
	B	4				28	0	15	
Ulmus americana	T				15				
	S		4						
	B		0		2				
Amelanchier alnifolia	S	1	32	4	2	24	31	11	1
	B	6	47	5	0	6	4	3	
Cornus species	S				48	1	17	28	0
	B				24	14		31	63
Crataegus rotundifolia	S		6		16	3	10	2	
	B								
Potentilla fruticosa	B								2
Prunus americana	S				0	5	13		
	B						1	3	
Prunus pennsylvanica	S			5					
	B			1					
Prunus virginiana	S	0	1		7	39	3	6	24
	B	23	23	7	23	67	51	29	
Ribes spp.	B	5	8		3	7	0	1	
Rosa woodsii	S								
	B	9	0	8					3
Salix spp.	T								
	B			1					
Shepherdia canadensis	B							1	4
Symphoricarpos occidentalis	B	37	5	30	22	6	22	14	2
Viburnum lentago	S			5					
	B			13					

Appendix E.

Relative cover values for woody species of the *Juniperus scopulorum, Pinus ponderosa* and *P. flexilis* habitat types in southwestern North Dakota. (T = tree, S = sapling, B = shrub).

		Juniperus scopulorum/ Oryzopsis micrantha ht			*Pinus ponderosa/ J. scopulorum* ht			*Pinus flexilis Agropyron spicatum* ht		
Site		**3**	**12**	**45**	**9**	**15**	**24**	**44**	**46**	**47**
Sec.		**NENW25**	**NESW20**	**SENE35**	**NENE16**	**NESE20**	**NESE10**	**SENE28**	**NWSW31**	**NWSW31**
Town.		**138N**	**140N**	**143N**	**136N**	**136N**	**136N**	**136N**	**135N**	**135N**
Range		**102W**	**102W**	**106W**	**102W**	**102W**	**102W**	**102W**	**105W**	**105W**
Fraxinus pennsylvanica	S	27								
	B	2								
Juniperus scopulorum	T	100	100	100	4	3	34		15	5
	S	73	100	100	18		18	4	13	21
	B	56	98	55					36	
Pinus flexilis	T								85	95
	S								87	79
	B								42	
Pinus ponderosa	T				96	97	66	100		
	S				77	100	82	96		
	B				79	15	25			
Potentilla fruticosa	B	24								
Prunus americana	S									
	B					1				
Prunus virginiana	S	7			4	29	5			
	B		2							
Rhus aromatica	S	1		1	9		5	100		
	B								22	50
Ribes species	B			43	4					
Shepherdia argentea	S	1								
	B									
Symphoricarpos occidentalis	B	8			8	55	65			50

Girard, Michele M., Harold Goetz, and Ardell J. Bjugstad. 1989. Native woodland habitat types of southwestern North Dakota. U.S. Department of Agriculture, Forest Service, Research Paper RM–281, 36 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Native woodland habitat types of southwestern North Dakota were classified. Forty-seven sites were sampled using Daubenmire methods and were analyzed using TWINSPAN classification and DECORANA ordination. A key was developed to identify habitat types, and the characteristics of each habitat type are described.

Keywords: Habitat types, woodlands, riparian, classification, wooded draws

Rocky Mountains

Southwest

Great Plains

U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

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